Maratha Vidya Prasarak Samaj's

Karmaveer Adv. Baburao Ganpatrao Thakare College of Engineering

An Autonomous Institute affiliated to Savitribai Phule Pune University, Pune

Udoji Maratha Boarding Campus, Gangapur Road, Nashik - 422 013, Maharashtra, India

Syllabus

First Year M. Tech. (2024 Pattern)

As per NEP 2020

Post-Graduate Program in Computer Engineering

Academic Year 2024-25

(Copy for Student Circulation Only)

First Year M. Tech. Curriculum Structure (2024 Pattern)
Computer Engineering
Semester - I

Course Code	Course Type	Course Name	Teaching Scheme (Hrs/Week)			Evaluation Scheme and Marks						Credits			
			TH	PR	TU	CCE	ESE	TW	PR	OR	TOT	TH	PR	TU	TOT
202101 202101L	PCC-1	Applied Algorithms Applied Algorithms Lab	3	4	-	50	50	25	25	-	**150**	3	2	-	**4**
202102 202102L	PCC-2	Distributed Operating Systems Distributed Operating Systems Lab	3	2	-	50	50	-	-	25	**125**	3	1	-	**4**
202103	PCC-3	Advanced Machine Learning	3	-	-	50	50	-	-	-	**100**	3	-	-	**3**
202104	PEC-I	Program Elective Course –I*	3	-	-	50	50	-	-	-	**100**	3	-	-	**3**
201104	ELC	Research Methodology & IPR@	4	-	-	50	50	-	-	-	**100**	4	-	-	**5**
202106	VSEC-1	Skill Development Laboratory - I	-	2	-	-	-	25	-	-	**25**	-	1	-	**1**
Total			**16**	**08**	**-**	**250**	**250**	**50**	**25**	**25**	**600**	**16**	**04**	**-**	**20**

Abbreviations: **TH:** Theory **PR:** Practical **TU:** Tutorial **CCE:** Continuous Concrete Evaluation
ESE: End-Semester Examination **TW:** Term Work **OR:** Oral **TOT:** Total

@ Common to All Branches.

Course Code	* Elective Course-I
202104A	Natural Language Processing and Text Mining
202104B	Cryptography and Network Security
202104C	Big Data Analytics
202104D	Software Architecture

Course Code	Skill Development Lab.-I
202106	Python Programming

First Year M. Tech. Curriculum Structure (2024 Pattern)
Computer Engineering
Semester - II

Course Code	Course Type	Course Name	Teaching Scheme (Hrs/Week)			Evaluation Scheme and Marks						Credits			
			TH	PR	TU	CCE	ESE	TW	PR	OR	TOT	TH	PR	TU	TOT
202201	PCC-4	Software Engineering and Project Management	3	-	-	50	50	-	-	-	100	3	-	-	3
202202 202202L	PCC-5	Natural Computing Natural Computing lab	3	4	-	50	50	25	25	-	150	3	2	-	5
202203 202203L	PEC-II	Program Elective Course -II** Program Elective Course –II Lab	3	2	-	50	50	-	-	25	125	3	1	-	4
202204	PEC-III	Program Elective Course -III***	3	-	-	50	50	-	-	-	100	3	-	-	3
202205	ELC-1	MOOC-I #	-	4	-	-	-	50	-	-	50	-	2	-	2
202206	ELC-2	Research Seminar-I	-	4	-	-	-	50	-	-	50	-	2	-	2
202207	VSEC-2	Skill Development Laboratory - II	-	2	-	-	-	25	-	-	25	-	1	-	1
Total			12	16	-	200	200	150	25	25	600	12	08	-	20

Course Code	** Elective Course-II	Course Code	*** Elective Course-III	Course Code	# MOOC-I
202203A	Deep Learning	202204A	Generative Artificial Intelligence	202205A	Research Publication and Ethics
202203B	Cloud Computing and Security	202204B	Ethical Hacking and Digital Forensics	202205B	AI for Economics
202203C	Data Modelling and Visualization	202204C	Information Retrieval and Web Mining	202205C	Industry 4.0 and Industrial IoT
202203D	Agile Software Development	202204D	DevOps	202205D	Ethical Hacking

Second Year M. Tech. Curriculum Structure (2024 Pattern)
Computer Engineering
Semester - III

Course Code	Course Type	Course Name	Teaching Scheme (Hrs/Week)			Evaluation Scheme and Marks						Credits			
			TH	PR	TU	CCE	ESE	TW	PR	OR	TOT	TH	PR	TU	TOT
202301	**ELC-3**	Dissertation Phase-I	-	20	-	-	-	100	-	100	**200**	-	10	-	**10**
202302	**ELC-4**	Research Seminar-II	-	8	-	-	-	50	-	50	**100**	-	4	-	**4**
202303	**ELC-5**	MOOC-II (Domain Specific) #		4	-	-	-	50	-	-	**50**	-	2	-	**2**
202304	**OJT/INT**	On-Job Training / Internship (Research/National/International)	-	8	-	-	-	100	-	50	**150**	-	4	-	**4**
Total			**-**	**40**	**-**	**-**	**-**	**300**	**-**	**200**	**500**	**-**	**20**	**-**	**20**

 # NPTEL, SWAYAM and other Massive Open Online Course (MOOC) approved by BoS

Second Year M. Tech. Curriculum Structure (2024 Pattern)
Computer Engineering
Semester - IV

Course Code	Course Type	Course Name	Teaching Scheme (Hrs/Week)			Evaluation Scheme and Marks						Credits			
			TH	PR	TU	CCE	ESE	TW	PR	OR	TOT	TH	PR	TU	TOT
202401	**ELC-6**	Dissertation Phase -II	-	40	-	-	-	200	-	100	**300**	-	20	-	**20**
Total			**-**	**40**	**-**	**-**	**-**	**200**	**-**	**100**	**300**	**-**	**20**	**-**	**20**

Abbreviations: **TH:** Theory **PR:** Practical **TU:** Tutorial **CCE:** Continuous Concrete Evaluation
ESE: End-Semester Examination **TW:** Term Work **OR:** Oral **TOT:** Total

- **Summary of Credits and Total Marks:**

Abb-reviations	Course Type	Number of Courses	Credits	% of Credits
PCC	Program Core Course	5	20	**25.0**
PEC	Program Elective Course	3	10	**12.5**
ELC	Experiential Learning Course	8	48	**60.0**
VSEC	Vocational and Skill Enhancement Course	2	2	**2.5**
Total		**18**	**80**	**100%**

• Definition of Credit :

The Post Graduate (P.G.) programmes will have credit system. The details of credit will be as follow.
1 Credit = 1 hour/week for lecture
= 2 hours/week for practical
= 1 hour/week for tutorial

Semester - I

Course Code: 202101	Course Name: Applied Algorithms	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week	**3**	**CCE :** 50 Marks **ESE :** 50 Marks

Prerequisite Courses:

- Introductory courses on programming, Data Structures, Discrete Structures, and Theory of Computation.

Course Objectives:

- To understand different algorithm designing techniques.
- To analyze the performance of algorithms.
- To apply various algorithmic strategies for problem-solving such as Greedy, Dynamic, Divide and Conquer, and Backtracking techniques.
- To design multithreaded algorithms for computational problems.
- To understand NP-complete and NP-hard computational problems.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand different algorithm design strategies.

CO2: Analyze the asymptotic performance of algorithms using recurrence equations.

CO3: Apply a suitable algorithm design strategy to solve a problem.

CO4: Construct optimal solutions by applying various methods.

CO5: Understand near-optimal solutions using randomization or approximation algorithms.

Course Content:

UNIT-I: Algorithmic Analysis **08 Hours**

Algorithm Design: Introduction, basic concerns, relationship between algorithms and other aspects of software, solving problems with a computer, development of a model, checking the correctness of the algorithm, growth of functions, performance analysis, amortized analysis, analyze and study the complexity of the algorithm. **Solving Recurrences**: substitution method, homogeneous recurrences, inhomogeneous recurrences, change of variable, range transformations, asymptotic recurrence.

UNIT-II: Divide - Conquer and Greedy Method **08 Hours**

Greedy method: General method, control Abstraction, minimum cost spanning trees, Prim's

algorithm, Kruskal's algorithm, Huffman's codes.

Divide and Conquer: General strategy, Control Abstraction, Binary Search, Merge sort, Quick Sort, Stassen's Matrix multiplication, Convex Hull.

UNIT-III: Dynamic Programming and Backtracking 08 Hours

Dynamic Programming: General method, control abstraction, the principle of optimality, binomial coefficients, OBST, longest common subsequence, single source shortest paths, Dijkstra's algorithm; **Backtracking strategy:** control abstraction, n queen's problem, M-coloring problems.

UNIT-IV: Randomized and Approximation Algorithms 08 Hours

Randomized algorithms: Reasons for using randomized algorithms, examples: randomized quick sort, min-cut. **Approximation algorithms:** The vertex cover problem, the traveling salesperson problem. **Multithreaded algorithms:** Basis of dynamic multithreading, multithreaded matrix multiplication, multithreaded merge sort. **Distributed algorithms:** Distributed breadth-first search, distributed minimum spanning tree.

UNIT-V: Complexity Theory 08 Hours

Classes P and NP, NP-completeness, Decision problems vs. optimization problems, its relevance to cryptography, reductions, polynomial-time, polynomial-time verification, NP-completeness and reducibility, 3-CNF satisfiability, Clique problem, Vertex cover problem, Hamiltonian cycle problem, Traveling-salesman problem.

Learning Resources:

Text Books:

1. Dave, Parag Himanshu, and Himanshu Bhalchandra Dave. *Design and analysis of algorithms*. Pearson Education India, 1900.
2. Horowitz and Sahani, *Fundamentals of Computer Algorithms*, University Press, ISBN: 978 817371 6126 7371 61262, 2nd edition.

Reference Books:

1. Cormen, Thomas H., et al. *Introduction to Algorithms*. MIT Press, 2022.
2. Brassard, Gilles, and Paul Bratley. *Fundamentals of Algorithmic*, Prentice-Hall, Inc., 1996.

Web link for MOOC / NPTEL Links

1. https://archive.nptel.ac.in/courses/106/106/106106131/
2. https://archive.nptel.ac.in/courses/106/101/106101060/

Course Code: 202101L	Course Name: Applied Algorithms Lab	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Practical: 4 Hours/Week	**2**	**TW : 25 Marks** **PR : 25 Marks**

Guidelines for Laboratory / Term Work Assessment:

Guidelines for Laboratory /Term Work Assessment Continuous assessment of laboratory work should be based on overall performance of Laboratory assignments by a student. Assessment of each Laboratory assignment will assign grade/marks based on parameters, such as timely completion, performance, innovation, efficient codes, punctuality, documentation and neatness.

List of Practicals

1. Implement quick sort / merge sort to demonstrate a divide and conquer strategy.
2. Implement a program to generate Huffman's code using the Greedy strategy.
3. Implement the longest common subsequence / OBST / Dijkstra's algorithm using dynamic programming.
4. Implement n-queen's problem using backtracking.
5. Implement multithreaded matrix multiplication / multithreaded merge sort.
6. Mini project: Find a minimum spanning tree by Prim's algorithm and Kruskal's algorithm using the Greedy strategy. Analyze and compare the performance of both.

Course Code: 202102	Course Name: Distributed Operating Systems	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week	**3**	**CCE :** 50 Marks **ESE :** 50 Marks

Prerequisite Courses:

- Operating System.

Course Objectives:

- To understand characteristics and challenges of distributed systems.
- To learn process management in distributed operating systems.
- To study various strategies of shared memory and inter process communication.
- To understand design principles of distributed file management

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Analyze the challenges in distributed OS.

CO2: Demonstrate the process of communication and synchronization.

CO3: Design application to retrieve the data stored in distributed memory.

CO4: Understand process scheduling and Management.

CO5: Compare different file systems.

Course Contents

UNIT-I: Fundamentals of Distributed System **08 Hours**

Review of networking protocols, point to point communication, operating systems, characteristics and properties of distributed systems, challenges, design issues, architectural models, multiprocessor and multicomputer systems, distributed operating systems, network operating systems, middleware concept, the client-server model, design approaches-kernel based-virtual machine based, application layering, distributed computing environment.

UNIT-II: Message Passing and Remote Procedure Calls **08 Hours**

Message passing: desirable features of good message passing systems, issues in IPC by message passing; synchronization, buffering, multi-datagram messages, encoding and decoding of message data, process addressing, failure handling and group communication.

Remote procedure call: RPC model, transparency of RPC, implementing RPC mechanisms, stub

generation, RPC messages, server management, parameter-passing semantics, call semantics communication protocols for RPC, client-server binding, RPC in heterogeneous environment, lightweight RPC.

UNIT-III: Synchronization and Distributed Shared Memory 08 Hours

Synchronization: Clock Synchronization, Event Ordering, Mutual Exclusion, Deadlock, Election Algorithms. **Distributed Shared Memory:** General architecture of DSM systems, design and implementation issues in DSM, granularity, structure of shared memory space, consistency models, replacement strategy, thrashing, heterogeneous DSM, advantages of DSM.

UNIT-IV: Resource and Process Management 08 Hours

Resource Management: desirable features of good global scheduling algorithm, task assignment approach, load-balancing approach, load-sharing approach.

Process management: Process migration, threads.

UNIT-V: Distributed File System and Naming 08 Hours

File-accessing models, file-sharing semantics, file-caching schemes, file replication, fault tolerance, atomic transactions, design principles. **Naming:** Fundamental terminologies and concepts, system-oriented names, object-locating mechanisms, human-oriented names, name cache, naming and security.

Learning Resources:

Text Books:

1. Pradeep K. Sinha, Distributed Operating Systems Concepts and Design, PHI

Reference Books:

1. A. S. Tanenbaum, Distributed Operating Systems, Pearson Education India
2. Mukesh Singhal and Niranjan Shivaratri, Advanced Concepts In Operating Systems, McGraw-Hill.
3. George Coulouris, Distributed Systems Concepts and Design.

Web link for MOOC / NPTEL Links

1. Distributed Systems Dr. Rajiv Mishra IIT Patna
   https://onlinecourses.nptel.ac.in/noc24_cs77/preview
2. Cloud Computing and Distributed Systems, Dr. Rajiv Mishra IIT Patna
   https://nptel.ac.in/courses/106104182

Course Code: 202102L	Course Name: Distributed Operating Systems Lab	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Practical : 2 Hours/Week	**1**	**OR : 25 Marks**

Guidelines for Laboratory /Term Work Assessment:

Guidelines for Laboratory /Term Work Assessment Continuous assessment of laboratory work should be based on overall performance of Laboratory assignments by a student. Assessment of each Laboratory assignment will assign grade/marks based on parameters, such as timely completion, performance, innovation, efficient codes, punctuality, documentation and neatness.

List of Practicals

1. **Message passing system development and Remote Procedure Call (RPC) system implementation.**

   Implement Synchronous and Asynchronous Communication: Set up both synchronous and asynchronous message-passing mechanisms between processes.

   Develop Client-Server Binding Mechanism: Implement static and dynamic binding techniques for client-server interaction.

2. **Synchronization in distributed systems and Distributed Shared Memory (DSM) system simulation**

   Implement Clock Synchronization Algorithms: Develop and test algorithms like the Network Time Protocol (NTP) or Lamport's logical clocks for synchronizing clocks across distributed nodes.

   Develop an Election Algorithm: Implement an election algorithm (e.g., Bully or Ring algorithm) for leader selection in a distributed system.

   Simulate Thrashing and Memory Replacement: Develop scenarios to simulate memory thrashing and implement strategies for memory replacement and management.

3. **Process migration module**

   Design process migration module: Create a process migration module that allows processes to be moved from one node to another in response to load changes or node failures.

4. **Design and implementation of a distributed file system**

   Design a DFS Architecture: Implement a basic distributed file system with file accessing and sharing semantics.

5. **Implementing Security Mechanisms in Distributed Systems**

Implement Authentication and Access Control: Set up user authentication mechanisms and access control policies to secure resources.

Develop Intrusion Detection Mechanisms: Implement basic intrusion detection systems (IDS) to detect and respond to security threats

Course Code: 202103	Course Name: Advanced Machine Learning	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week	**3**	**CCE :** 50 Marks **ESE :** 50 Marks

Prerequisite Courses:

- Probability, Statistics and Data Mining

Course Objectives:

- To understand basic concepts and possible applications of machine learning.
- To illustrate various data preprocessing methods and supervised, unsupervised machine learning techniques.
- To apply regression, classification and clustering algorithms for suitable machine learning problems.
- To study the neural networks, learning algorithms and its applications.
- To apply advanced machine learning methods for suitable applications.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand the basic concepts, state-of-the art techniques of machine learning.

CO2: Evaluate regression methods for real world applications.

CO3: Apply supervised learning algorithms for real world problems.

CO4: Study unsupervised learning algorithms problems in machine learning.

CO5: Apply neural network models to solve complex problems.

Course Contents

UNIT-I: Introduction of Machine Learning 08 Hours

Introduction: Different types of learning, models of machine learning: geometric models, probabilistic models, logical models, grouping and grading models, parametric and non-parametric models, reinforcement learning and concepts of Markov decision process, multi-instance learning.

Features: Concept of feature, data preprocessing, data cleaning, data reduction by attribute sub-set selection, and data transformation by normalization. Steps in developing a machine learning application.

UNIT-II: Regression in Machine Learning 08 Hours

Linear classifier and classification, gradient descent algorithm, stochastic gradient descent, sub gradients, stochastic gradient descent for risk minimization, bias/variance tradeoff, error analysis, under-fitting vs over-fitting problems.

UNIT-III: Supervised Learning Algorithms 08 Hours

Classification concepts, binary, multi-class and multi-label classification, k-nearest neighbor, decision trees, Classification and Regression Trees (CART). **Bayesian Learning:** Naïve Bayes Classifier, Bayesian belief networks, support vector machines as a linear and non-linear classifier. Ensemble methods. Metrics for evaluating classifier performance.

UNIT-IV: Unsupervised Learning Algorithms 08 Hours

Basic concepts of clustering, distance based clustering- K-means algorithm, hierarchical clustering, probability-based clustering, expectation maximization algorithm, self-organizing maps, evaluation of clustering.

UNIT-V: Neural Networks & Learning Algorithms 08 Hours

Neural networks: Artificial neural networks, perceptron, expressive power of neural networks, multilayer networks, back propagation.

Introduction to deep learning: CNNs, popular CNN architectures, RNNs, introduction to Generative Adversarial Networks (GANs) and transfer learning.

Learning Resources:

Text Books:

1. Ian. H. Witten, Eibe Frank, Mark A. Hall, Christopher J.Pal, Data Mining, Practical Machine Learning Tools and Techniques, Fourth Edition, Morgan Kaufmann, 2017.ISBN : 978-0-12804291-5
2. Tom Mitchell, Machine Learning, McGraw-Hill.
3. Fundamentals of Machine Learning for Predictive Data Analytics, John D Kelleher, MIT Press.
4. Josh Patterson, Adam Gibson, Deep Learning: A Practitioner's Approach, O'Reilly Media, Inc, 2017, ISBN No.: 9781491914250.

Reference Books:

1. Jiawei Han, Micheline Kamber, and Jian Pie, Data Mining: Concepts and Techniques, Elsevier Publishers Third Edition, ISBN: 9780123814791, 9780123814807.
2. E. Alpaydin, Machine Learning, MIT Press, 2010
3. Hastie, Trevor, et al., The elements of statistical learning: data mining, inference, and prediction, Vol. 2. New York: springer, 2009.
4. Bishop, C. M. (2006). Pattern Recognition and Machine Learning, Springer.
5. O. Duda, Peter E. Hart, David G. Stork, Pattern Classification Second edition John Wiley, 2001.

Weblink for MOOC / NPTEL Links

1. https://nptel.ac.in/courses/106105152
2. https://nptel.ac.in/courses/106106139
3. https://cognitiveclass.ai/courses/machine-learning-with-python
4. https://onlinecourses.nptel.ac.in/noc20_cs62/preview
5. https://doi.org/10.3390/computation11030052

Activity based Learning (Suggested Activities in Class)

1. Flipped classroom.
2. Online interactive tool.
3. Virtual lab.
4. Collaborative and individual problem-based learning.
5. Quizzes/assignment.

Course Code: 202104A	Course Name: Natural Language Processing and Text Mining	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week	**3**	**CCE :** 50 Marks **ESE :** 50 Marks

Prerequisite Courses:

- Discrete Mathematics, Theory of Computation, Probability and Statistics

Course Objectives:

- To understand the fundamentals of Natural language processing.
- To develop the various language modeling techniques for NLP
- To explore various techniques for processing and analyzing textual data.
- To learn about different machine learning and deep learning models used in NLP
- To apply NLP techniques for text mining, sentiment analysis, and information retrieval.

Course Outcomes:

On completion of the course, learner will be able to:

CO1: Demonstrate the understanding of basic concepts and techniques in NLP.

CO2: Implement and evaluate part-of-speech taggers and parsers for a language and build language models.

CO3: Analyze syntax and semantics of natural language data.

CO4: Develop word embedding and evaluate models for tasks like sentiment analysis, machine translation for real world applications.

CO5: Implement text mining techniques to extract meaningful patterns and insights from textual data.

Course Contents

UNIT-I: Introduction to Natural Language Processing **08 Hours**

Introduction: Natural Language Processing and Linguistics, Fundamentals of NLP, stages of NLP, problems in NLP, applications of NLP. **Approaches of NLP:** Rule based, data based, knowledge based approaches. **Linguistic essentials:** Phonology, morphology, syntax, semantics, and pragmatics. **Text preprocessing:** Tokenization, stemming, lemmatization, and stopword removal, Porters algorithm.

UNIT-II: POS Tagging and Language Modeling 08 Hours

Sequence labeling tasks of NLP, POS tagging, POS tag sets, Hidden Markov Model-Introduction, Markov Processes, HMM characterization-Likelihood of a sequence (Forward Procedure, Backward Procedure), Best state sequence (Viterbi Algorithm) N-gram Language Modeling-context sensitive spelling correction, probabilistic language model, auto completion prediction, evaluation and perplexity, smoothing techniques.

UNIT-III: Syntax and Semantics Analysis 08 Hours

Constituency parser: Syntactic structure, parsing methodology, different parsing algorithms, probabilistic parsing, CKY algorithm, issues in parsing, dependency parsing- syntactic structure, parsing methodology, transition-based dependency parsing, graph-based dependency parsing, evaluation, co-reference resolution, named-entity recognition

Semantics: word senses, word relations, word similarity and thesaurus methods, name entity recognition, word sense disambiguation, WordNet. Supervised and unsupervised disambiguation, dictionary-based disambiguation.

UNIT-IV: Applications of NLP 08 Hours

Word embedding: one-hot vectors, methods of generating word embedding, Skip-gram, CBOW, Word2Vec, GloVe, FastText, and their applications. Information retrieval and extraction, machine translation, text generation, recommendation system attention mechanisms: self-attention and multi-head attention in NLP tasks, Deep Learning in NLP: RNNs, LSTMs, GRUs and transformers. **Language models:** BERT, GPT and other transformer-based models. Sentiment analysis.

UNIT-V: Introduction to Text Mining 08 Hours

Overview of text mining, general architecture, core operations, preprocessing techniques, document classification, information extraction, evaluation of performance, sentiment analysis. **Text categorization:** machine learning approach to text categorization. Latent Dirichlet allocation for text classification, latent semantic indexing, probabilistic latent semantic indexing. Text clustering: supervised and unsupervised clustering. Text summarization techniques.

Learning Resources:

Text Books:

1. Jurafsky, David, and James H. Martin, ―Speech and Language Processing: An Introduction to Natural Language Processing‖, Computational Linguistics and Speech Recognition‖, , PEARSON Publication
2. Jacob Eisenstein, ―Natural Language Processing‖, MIT Press

3. Ronen Feldman, James Sanger The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data, Cambridge University Press, 2007.

Reference Books:

1. Yoav Goldberg, Neural Network Methods for Natural Language Processing, Morgan & Claypool Publishers, 2017.
2. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016.
3. Tommy Blanchard, Debasish Behera, and Delip Rao, Natural Language Processing with PyTorch: Build Intelligent Language Applications Using Deep Learning, Packt Publishing, 2019.
4. Jacob Eisenstein, An Introduction to Information Retrieval, Cambridge University Press.
5. Christopher D. Manning, Prabhakar Raghavan, and Hinrich Schütze, Introduction to Information Retrieval, Cambridge University Press, 2008.

Weblink for MOOC / NPTEL Links

1. https://nptel.ac.in/courses/106106211
2. https://onlinecourses.nptel.ac.in/noc24_cs39/preview
3. https://www.coursera.org/specializations/natural-language-processing

Course Code: 202104B	Course Name: Cryptography & Network Security	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week	**3**	**CCE :** 50 Marks **ESE :** 50 Marks

Prerequisite Courses:

- Operating System, Computer Networks.

Course Objectives:

- To understand the principles and practices of cryptography and network security.
- To study various encryption and decryption techniques and their applications.
- To explore the mathematical foundations required for cryptography.
- To examine various protocols for securing network communication and data integrity.
- To analyze contemporary security threats and the mechanisms to mitigate them.

Course Outcomes:

On completion of the course, learner will be able to:

CO1: Explain the fundamental concepts of cryptography, including classical encryption techniques and the mathematical principles that underpin modern cryptographic algorithms.

CO2: Analyze and implement symmetric key cryptographic algorithms and understand the importance of key management and cryptanalysis techniques in ensuring data security.

CO3: Apply asymmetric key cryptographic algorithms for secure key exchange, digital signatures, and understand the role of Public Key Infrastructure (PKI) in digital security.

CO4: Critically evaluate and implement various network security protocols to ensure secure communication and protect against network-based attacks.

CO5: Explore advanced cryptographic techniques and apply appropriate countermeasures to address contemporary security threats.

Course Contents

UNIT-I: Introduction to Cryptography **08 Hours**

Overview of Cryptography: History, types (symmetric vs asymmetric), and applications.

Classical Cryptography: Substitution and transposition ciphers, rotor machines, cryptanalysis. Mathematical Foundations: Modular arithmetic, Euclidean algorithm, prime numbers, and discrete logarithms.

UNIT-II: Symmetric Key Cryptography 08 Hours

Block Ciphers: DES, 3DES, AES, Feistel structure, modes of operation (ECB, CBC, CFB, OFB, and CTR). Stream ciphers: RC4, LFSR-based ciphers. **Cryptanalysis of symmetric key ciphers:** Linear and differential cryptanalysis. Key management: Key distribution, key exchange protocols (e.g., Diffie-Hellman).

UNIT-III: Asymmetric Key Cryptography 08 Hours

Public key cryptography: RSA, ElGamal, and ECC. Key management: Public key infrastructure (PKI), digital certificates, certificate authorities. **Cryptographic hash functions:** MD5, SHA family, and their applications. Digital signatures and authentication: RSA and DSA-based digital signatures, HMAC.

UNIT-IV: Network Security Protocols 08 Hours

Authentication Protocols: Challenge-response, Kerberos. Secure Communication Protocols: SSL/TLS, IPSec, VPNs. Wireless Network Security: WEP, WPA, WPA2. Email Security: PGP, S/MIME.

UNIT-V: Advanced Topics in Cryptography & Network Security 08 Hours

Elliptic curve cryptography: Basics, applications in encryption and digital signatures. Blockchain Technology: Cryptographic principles, consensus algorithms, security aspects.

Quantum cryptography: Quantum key distribution, post-quantum cryptography. Security Threats and Countermeasures: DDoS, ransomware, intrusion detection systems (IDS), firewalls, and honeypots. Application Security: Approaches, Security Threats, Tools for Application Security Testing.

Learning Resources:

Text Books:

1. William Stallings, Cryptography and Network Security: Principles and Practice, Pearson.
2. Bruce Schneier, Applied Cryptography: Protocols, Algorithms, and Source Code in C, Wiley.
3. William Stallings, Network Security Essentials: Applications and Standards, Pearson.

Reference Books:

1. Christof Paar and Jan Pelzl, Understanding Cryptography: A Textbook for Students and Practitioners, Springer.
2. Behrouz A. Forouzan and Debdeep Mukhopadhyay, Cryptography and Network Security, McGraw-Hill.

3. William Stallings and Lawrie Brown, Computer Security: Principles and Practice, Pearson.
4. Jonathan Katz and Yehuda Lindell, Introduction to Modern Cryptography: Principles and Protocols, CRC Press.

Weblink for MOOC / NPTEL Links

1. Cryptography & Network Security, By Prof. Sourav Mukhopadhyay, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc21_cs16/preview
2. Web Application Security Overview https://msdn.microsoft.com/en-us/library/ff648636.aspx
3. Web Application Vulnerability Scanners http://samate.nist.gov/index.php/Web_Application_Vulnerability_Scanners.html

Course Code: 202104C	Course Name: Big Data Analytics	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week	**3**	**CCE :** 50 Marks **ESE :** 50 Marks

Prerequisite Courses:

- Database Management Systems, Data mining and Warehousing.

Course Objectives:

- To develop problem solving abilities using Mathematics.
- To apply algorithmic strategies while solving problems.
- To develop time and space efficient algorithms.
- To study algorithmic examples in distributed, concurrent and parallel environments.

Course Outcomes:

On completion of the course, learner will be able to:

CO1: Explore the life cycle phases of data Analytics.

CO2: Apply statistical methods for evaluation of problems.

CO3: Understand association rules, regression and solve problems using classification algorithms for various applications.

CO4: Analyze advanced analytics method for text mining.

CO5: Apply applications for business analytics and intelligence.

Course Contents

UNIT-I: Introduction to Data Analytics and Life Cycle 08 Hours

Introduction: Big data overview, state of the practice in Analytics- BI Vs data science, current analytical architecture, drivers of big data, emerging big data ecosystem and new approach. Key roles for the new big data ecosystem life cycle: overview, phase 1-discovery, phase 2-data preparation, phase 3-model planning, phase4-model building, phase 5- communicate results, phase 6-operationalize.

UNIT-II: Statistical Methods 08 Hours

Damage basic data analytics methods, statistical analysis: mean, median, mode, regression coefficient, IQR,SD, variance, correlation coefficient, kurtosis, **Exploratory data analytics:** dirty data, visualizing a single variable, examining multiple variables, data exploration versus

presentation statistical methods for evaluation: hypothesis testing, difference of means, Wilcoxon rank-sum test, type I and type II errors, power and sample size, ANOVA.

UNIT-III: Association Rules, Regression & Classification 08 Hours

Advanced analytical theory and methods: Association rules overview, Apriori algorithm, evaluation of candidate rules, validation and testing, diagnostics, Regression- linear, logistics, reasons to choose and cautions, additional regression models.

Classification: decision trees, overview, general algorithm, decision tree algorithm, evaluating a decision tree. Naïve Bayes algorithm, smoothing and diagnostics. Additional classification methods.

UNIT-IV: Text Analytics 08 Hours

Text analysis steps, a text analysis example, collecting raw text, representing text, Term Frequency (TF), Inverse Document Frequency (TFIDF), categorizing documents by topics, determining sentiments, gaining insights.

UNIT-V: Technology and Tools 08 Hours

Analytics for unstructured data-Use cases Map Reduce, Apache Hadoop, Hadoop Ecosystem-Pig, HIVE, HBase, Mahout, NoSQL An Analytics Project-Communicating, operationalizing, creating final deliverables. Introduction to data visualization, types of data visualization, visualizing big data tools used in data visualization, analytical techniques used in big data visualization.

Learning Resources:

Text Books:

1. David Dietrich, Barry Hiller, Data Science and Big Data Analytics, EMC education services, Wiley publications, 2012, ISBN0-07-120413-X.

Reference Books:

1. Va O'Neil, Cathy, and Rachel Schutt. *Doing data science: Straight talk from the frontline*. O'Reilly Media, Inc., 2013.

Weblink for MOOC / NPTEL Links

1. https://archive.nptel.ac.in/courses/110/106/110106072/
2. https://archive.nptel.ac.in/noc/courses/noc17/SEM2/noc17-mg24/

Course Code: 202104D	Course Name: Software Architecture	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week	**3**	**CCE :** 50 Marks **ESE :** 50 Marks

Prerequisite Courses:

- Object Oriented Software Engineering, Programming language.

Course Objectives:

- To introduce basic concepts and principles about software design and software architecture.
- To learn practical approaches and methods for creating and analyzing software architecture.
- To familiarize with the interaction between quality attributes and software architecture.
- To experience with examples in design pattern application and case studies in software architecture.

Course Outcomes:

On completion of the course, learner will be able to:

CO1: Build knowledge on software architecture and behavior of real world objects.

CO2: Develop architectural approaches from requirements and manage traceability between architecture and requirements.

CO3: Design software architecture for a selected software system.

CO4: Design models to show the importance of systems analysis in solving problems.

CO5: Apply the design pattern oriented approach for real world problems.

Course Contents

UNIT-I: Software Architecture Concepts **08 Hours**

Fundamentals of software architecture: Prescriptive vs Descriptive Architecture, Architectural Design- DSSA, Architectural Models, Architectural Pattern. **Architectural Styles:** Middleware **Architectural Style:** C2 and CORBA, JDBC, Connectors: Roles, Types of Connector. **Data Distribution connector:** Event based, Grid-based, Client-server based, P2P based.

UNIT-II: Architectural Modelling **08 Hours**

Architectural modelling, modeling concepts, ambiguity, accuracy, and precision, description language: Darwin, Rapide, Wright. Domain and style-specific ADLs: Koala, Weaves AADL. **Visualization techniques:** Textual, informal graphical editor, UML, LTSA, xADL 2.0, MTAT Object Oriented Software Engineering, programming language.

UNIT-III: Architectural Analysis 08 Hours

Architectural Analysis: requirement for architectural and the life cycle view of architectural design and analysis method, analysis goal, scope of analysis, types of analysis: economic analysis: ATAM, CBAM, model based: Wright, reliability analysis.

UNIT-IV: Distributed and Networked Architectures 08 Hours

Applied architectures and styles, designing for nonfunctional properties: distributed and networked architectures, architectures for network-based applications, decentralized architectures, service-oriented architectures and web services, efficiency, complexity, scalability and heterogeneity, adaptability, dependability.

UNIT-V: Design Patterns 08 Hours

Design Patterns: Architecture description languages; product-line architectures; component based development.

Design Patterns: Basic patterns: facade, adapter, flyweight; **Delegates:** visitors, command, memento; grammars: composite, decorator, interpreter; **Frameworks:** Template method, factory, abstract factory; separation of concerns: observer, mediator, model view-controller.

Learning Resources:

Text Books:

1. Richard N. Taylor, Nenad Medvidovic, Eric M. Dashofy, Software Architecture: Foundation, Theory and Practice, Wiley, India , 2009
2. Design patterns, Erich Gamma, Richard Helan, Ralph Johman , John Vlissides, Pearson Publication,2013.
3. Erich Gamma, Design Patterns, Pearson, ISBN 0-201-63361-2.

Reference Books:

1. Frank Buschmann, Regine Meunier, Hans Rohnert, Peter Sommerlad, Miachel Stal, Douglas Schmidt.Pattern Oriented Software Architecture, Volumes 1 and 2.
2. M. Shaw and D.Garlan, Software Architecture: Perspectives on an Emerging Discipline, Pearson , 2006
3. Len Bass, Paul Clements, Rick Katzman, Ken Bass. Software Architecture in Practice.

Weblink for MOOC / NPTEL Links

1. https://onlinecourses.nptel.ac.in/noc22_cs39/preview
2. https://onlinecourses.nptel.ac.in/noc20_cs68/preview

Course Code: 201104	Course Name: Research Methodology & IPR	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 4 Hours/Week	**4**	**CCE : 50 Marks** **ESE : 50 Marks**

Prerequisite Courses:

- Students should complete undergraduate courses in engineering/technology.

Course Objectives:

- To provide an overview of the research problem and describe the functions of literature survey in research.
- To explain the statistical and probability analysis.
- To explain the art of writing research reports and papers.
- To understand the patenting process and its commercial aspects.
- To explain patent rights and new developments in IPR.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand research problem formulation, approaches of investigation of solutions for research problems and literature survey.

CO2: Apply the principles of statistics and probability analysis in research.

CO3: Acquire skills in research proposal/paper writing.

CO4: Discover the importance of IPR.

CO5: Understand patent rights and new developments in IPR.

Course Content:

UNIT-I: Research Problem and Literature Survey **11 Hours**

Research Problem: Meaning of research problem, sources of research problem, characteristics of a good research problem, and errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problems, data collection, benchmarking, analysis, interpretation

Literature survey: Effective literature studies approaches, analysis, Plagiarism, its importance and software's, research ethics, research gap, writing objectives of research studies.

UNIT-II: Statistics and Probability Analysis **10 Hours**

Statistical Analysis: Introduction, Sources of error and uncertainty, One-Dimensional Statistics: combining errors and uncertainties, t-test, ANOVA statistics.

Probability Analysis: Classical and empirical probability, axioms of probability, conditional probability, Bayes' rule, law of total probability and law of total expectation.

UNIT-III: Technical Writing **11 Hours**

Characteristics of effective technical writing, developing a Research proposal, format of the research proposal, financial heads of the research project, research paper writing, abstracting and indexing of journals, impact factor, h index, research paper submission and review process, writing responses to reviewer's comments, Publications.

UNIT-IV: Intellectual Property **10 Hours**

Patents, designs, trade and copyright, the process of filing patents, designs, trade and copyright, examination, examination report, writing responses to the examination report, patent grant, commercialization, patenting under PCT and its advantages, case studies.

UNIT-V: Patent Rights and New Developments in IPR **11 Hours**

Scope of patent rights, Licensing and transfer of technology, patent information and databases, geographical Indications. Administration of patent system, new developments in IPR, IPR of biological systems, computer software etc.

Learning Resources:

1. Research Methodology: Methods and Trends, by Dr. C. R. Kothari.
2. Research Methodology: An Introduction by Wayne Goddard and Stuart Melville.
3. Research Methodology: A Step by Step Guide for Beginners, by Ranjit Kumar, 2nd Edition.
4. Halbert, Resisting Intellectual Property, Taylor & Francis Ltd.
5. Mayall, Industrial Design, McGraw Hill.
6. Niebel, Product Design, McGraw Hill.
7. T. Ramappa, Intellectual Property Rights under WTO, S. Chand.
8. Paul L. Meyer, Introductory probability and statistical applications, Addison-Wesley Publishing Company, 1970.

Web link for MOOC / NPTEL Links

1. www.ipindia.gov.in
2. www.nptel.ac.in/courses/121106007

Course Code: 202105	Course Name: Skill Development Laboratory-I Python Programing	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Practical : 2 Hours/Week	**1**	**TW : 25 Marks**

Prerequisite Courses:

- Data Structure and Problem Solving, Object Oriented Programming Concepts.

Course Objectives:

- To understand Python programming.
- To analyze and demonstrate knowledge of statistical data analysis techniques for decision making.
- To explore functions in Python for evaluating performance of the designed model.

Course Outcomes:

On completion of the course, learner will be able to:

CO1: Apply Python programming for real time problems.

CO2: Implement data pre-processing and visualization techniques in Python.

CO3: Illustrate data visualization using Python.

CO4: Perform text pre-processing on data.

CO5: Analyze the performance of the designed model.

Guidelines for Laboratory /Term Work Assessment:

Guidelines for Laboratory /Term Work Assessment Continuous assessment of laboratory work should be based on overall performance of Laboratory assignments by a student. Assessment of each Laboratory assignment will assign grade/marks based on parameters, such as timely completion, performance, innovation, efficient codes, punctuality, documentation and neatness.

Learning Resources:

Text Books:

1. Reema Thareja, Python Programming Using Problem Solving Approach, Oxford University Press, ISBN 13: 978-0-19-948017-6.
2. R. Nageswara Rao, Core Python Programming, Dreamtech Press; Second edition ISBN10: 938605230X, ISBN-13: 978-9386052308 ASIN: B07BFSR3LL.

Reference Books:

1. Martin C. Brown, Python: The Complete Reference, McGraw Hill Education, ISBN-10: 9789387572942, ISBN-13: 978-9387572942, ASIN: 9387572943.
2. Romano Fabrizio, Learning Python, Packt Publishing Limited, ISBN: 9781783551712, 1783551712.
3. Paul Barry, Head First Python- A Brain Friendly Guide, SPD O'Reilly, 2nd Edition, ISBN:978-93-5213-482-3.

Web link for MOOC / NPTEL Links

1. SWAYAM - Programming in Python by Dr. Rizwan Rehman, Dibrugarh University. https://onlinecourses.swayam2.ac.in/cec22_cs20/preview
2. NPTEL - The Joy of Computing using Python by Prof. Sudarshan Iyengar, IIT Ropar https://onlinecourses.nptel.ac.in/noc24_cs57/preview

Guidelines for Laboratory /Term Work Assessment:

Guidelines for Laboratory /Term Work Assessment Continuous assessment of laboratory work should be based on overall performance of Laboratory assignments by a student. Assessment of each Laboratory assignment will assign grade/marks based on parameters, such as timely completion, performance, innovation, efficient codes, punctuality, documentation and neatness.

List of Practicals:

1. Locate an open source dataset from web and apply various preprocessing operations such as handling missing values, one hot encoding, label encoding and data normalization on the it.
2. Download the Iris flower dataset and perform following operations.

   e.g., https: // archive.ics.uci.edu/ml/datasets /Iris.

   Scan the dataset and give the inference as:

   a. List down the features and their types (e.g., numeric, nominal) available in the dataset.
   b. Create a histogram for each feature in the dataset to illustrate the feature distributions.
   c. Create a boxplot for each feature in the dataset.
3. Compare distributions and identify outliers.

   Create a Linear Regression Model using Python to predict home prices using Boston Housing Dataset. The Boston Housing dataset contains information about various houses in Boston through different parameters.

   https://www.kaggle.com/c/boston-housing
4. Implement Naïve Bayes classification algorithm using Python on breast cancer dataset. Compute Confusion matrix to find TP, FP, TN, FN, Accuracy, Error rate, Precision, Recall on the given dataset.

   https://www.kaggle.com/datasets/yasserh/breast-cancer-dataset
5. Use the following dataset and classify tweets into positive and negative tweets.

   https://www.kaggle.com/ruchi798/data-science-tweets

6. Extract a sample document and perform text analytics on it.
   a. Apply document preprocessing methods: Tokenization, POS Tagging, stop words removal, Stemming and Lemmatization.
   b. Create representation of documents by calculating Term Frequency and Inverse Document Frequency.
7. Mini Project: Develop a book recommendation model using the scikit-learn library in python.

   https://github.com/tyedem/Books-RecommendationSystem/blob/main/Resources/books.csv

Semester - II

Course Code: 202201	Course Name: Software Engineering and Project Management	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week	**3**	**CCE :** 50 Marks **ESE :** 50 Marks

Prerequisite Courses:

- Problem solving Approach.

Course Objectives:

- To understand fundamentals of Software Engineering.
- To practice various testing technics.
- To understand the various version control tools.
- To understand project management through lifecycle.
- To understand various advance practices.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand Software Development process and its models.

CO2: Analyze the cost estimation of project and use of version control tools.

CO3: Apply a suitable project management strategy to manage a project.

CO4: Applying various methods by using advance tools.

CO5: Understand the Implementation of emerging technologies along with ethics.

Course Content:

UNIT-I: Fundamentals of Software Engineering **08 Hours**

Introduction to SDLC, Software process framework, umbrella activities, study of process models - waterfall model, iterative, spiral, agile methodology. Evolutionary process models: Prototyping model, spiral model, concurrent development model, study of CASE in software engineering.

Basics of Software Design: UML Diagrams- structure diagrams: Class diagram, behavioral diagrams: Use case diagram, activity diagram, state machine diagram, data flow diagram.

UNIT-II: Recent Trends in Software Engineering **08 Hours**

Estimation Models: Structure, COCOMO II, sstimation of Object-oriented Projects, specialized estimation. **Artificial Intelligence in Software Engineering**: AI-assisted development (e.g., GitHub Copilot, ChatGPT for code).

Introduction to Software Testing : Principles of testing, testing life cycle, phases of testing, types

of testing, verification and validation, defect management, defect life cycle, bug reporting, GUI testing, AI in software testing and defect prediction, use of Software engineering tools – Selenium.

UNIT-III: Fundamentals of Project Management 08 Hours

Project initiation, planning scope management, project management frameworks: traditional vs. agile project management (Scrum, Kanban). Work Breakdown Structure (WBS) and Gantt Charts, Critical Path Method (CPM). Core concepts: Scope, time, cost, quality, and risk management. Program Evaluation and Review Technique (PERT).

UNIT-IV: Advanced Project Management Practices 08 Hours

Quality Assurance - Test-driven development (TDD) and behavior-driven development (BDD), Advanced tools and techniques: Introduction to project scheduling tools (JIRA), Advanced project lifecycle models - Agile and hybrid models, Scaled Agile Framework (SAFe). Disciplined Agile Delivery (DAD). Hybrid project management methodologies - Data-driven decision making. Understanding of Power BI: Microsoft's tool for creating dashboards and real-time project metrics.

UNIT-V: Integration of Software Engineering and Project Management 08 Hours

Emerging Technologies in Project Management: AI and machine learning for resource allocation and scheduling, blockchain for project tracking and transparency. **DevOps as a Bridge**: Role of DevOps in unifying software engineering and project management. Metrics for DevOps success: Lead time, Deployment frequency. **Ethics and Professional Practices:** Ethical issues in software projects: Bias in AI, data privacy. Standards and certifications (CMMI, ISO/IEC 12207). **Future Trends:** Quantum computing and its impact on software engineering, sustainability in software projects and green computing.

Learning Resources:

Text Books:

1. Roger S. Pressman, Software Engineering-A Practitioners approach, 7th Edition, Tata McGraw Hill, ISBN 0-07-337597-7
2. Ian Sommerville, Software Engineering, Addison and Wesley, ISBN 0-13-703515-2

Reference Books:

1. Pankaj Jalote: An Integrated Approach to Software Engineering, Wiley India.
2. Software Engg: Principles and Practice, Hans van Vliet, Wiley India, 3rd Edition, 2010.

Web link for MOOC / NPTEL Links

1. https://onlinecourses.nptel.ac.in/noc20_cs68/preview
2. https://onlinecourses.nptel.ac.in/noc24_mg01/preview

Course Code: 202202	Course Name: Natural Computing	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week	**3**	**CCE :** 50 Marks **ESE :** 50 Marks

Prerequisite Courses:

- Applied Algorithm, Advanced Machine Learning.

Course Objectives:

- To learn how natural and biological systems influence computational field.
- To understand the strengths and weaknesses of nature-inspired algorithms.
- To learn the functionalities of various Bio-inspired optimization algorithms.
- To understand the need of optimization Algorithms.
- To apply the optimization techniques while solving the problems.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Relate the natural phenomena to computational world.

CO2: Construct neural networks for problem solving.

CO3: Develop solutions for computational problems using evolution concepts.

CO4: Apply nature-inspired algorithms for optimization.

CO5: Infer the appropriate strategy based on bio-inspired algorithms.

Course Contents

UNIT-I: Introduction to Natural Computing **08 Hours**

From nature to natural computing, sample idea, philosophy of natural computing, natural computing approaches, natural phenomena, models, and metaphors. From nature to computing and back again, general concepts – individuals, entities, agents; parallelism and distributivity; interactivity; adaptation; feedback; self-organization; bottom-up vs top-down. Problem solving as a search track, hill climbing, simulated annealing.

UNIT-II: Neural Networks **08 Hours**

Neural networks, application scope of neural networks, fundamental concepts of neural networks, McCulloch Pitts neuron, linear separability, perceptron networks, back – propagation networks, evolution and basic model of artificial neural network, network architecture, important

terminologies of ANNs, Learning Approaches, ANNs and Learning algorithms.

UNIT-III: Evolutionary Computing 08 Hours

Evolutionary computing: Evolutionary biology, evolutionary computing – standard evolutionary algorithm; genetic algorithm, evolutionary strategies, genetic programming, evolutionary programming. Genetic algorithms-initialize population, fitness evaluation, reproduction, crossover and mutation, examples of GA.

UNIT-IV: Optimization Algorithms 08 Hours

Swarm intelligence-biological motivation, from natural to artificial, ant colony characteristics, standard algorithm of ant colony optimization, ant clustering algorithm, traveling salesman problem, honey bee characteristics, bee colony optimization. Particle Swarm Optimization (PSO)-Introduction, swarm behavior, PSO algorithm, variants of PSO algorithm, applications.

UNIT-V: Biological Motivation and Artificial Life 08 Hours

Biological motivation, from natural to artificial, firefly algorithm, framework for self-tuning algorithms - case study of firefly algorithm, immune system, artificial immune systems - biological motivation, design principles, main types of algorithms. Introduction - artificial life the essence of life, examples of ALife projects, scope of artificial life, current trends and open problems.

Learning Resources:

Text Books:

1. L. N. de Castro, Fundamentals of Natural Computing: Basic Concepts, Algorithms, and Applications, 2006, CRC Press, ISBN-13: 978-1584886433
2. D. Floreano and C. Mattiussi, Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies, 2008, MIT Press, ISBN-13: 978-0262062718.

Reference Books:

1. Sam Jones (Editor), Bio Inspired Computing-Recent Innovations and Applications, Clanrye International; 2 edition (2 January 2015), ISBN-10: 1632400812.
2. Yang Xiao (Editor), Bio-Inspired Computing and Networking, CRC Press.
3. Innovations in Bio-Inspired computing and Applications, Conference proceedings, Springer.
4. Vasuki A., Nature Inspired Optimization Algorithms, CRC Press, 2020.

Web link for MOOC / NPTEL Links

1. Introduction to Soft Computing by Prof. Debasis Samanta, IIT Kharagpur. https://archive.nptel.ac.in/courses/106/105/106105173/

Course Code: 202202L	Course Name: Natural Computing Lab	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Practical : 4 Hours/Week	**2**	**TW** : 25 Marks **PR** : 25 Marks

List of Practicals

1. A linear equation is to be solved with the help of genetic algorithms applying initial population, fitness evaluation, reproduction, crossover and mutation. Find out the approximate values of the coefficients in the linear equation.
2. Implement Particle Swarm Optimization for the feature selection in any dataset. Compare the performance of a classification algorithm before and after the application of PSO. Comment on the improvement over the use of PSO.
3. Linear regression by using ANN: Implement Boston housing price prediction problem by Linear regression using ANN. Use Boston House price prediction dataset
4. Design an X-OR Gate with neural network classifier.
5. Implementation of Particle Swarm Optimization/ Ant Colony optimization for Traveling Salesman Problem.
6. Mini -Project.

Course Code: 202203A	Course Name: Deep Learning	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week	**3**	**CCE :** 50 Marks **ESE :** 50 Marks

Prerequisite Courses:

- Advanced Machine Learning.

Course Objectives:

- To understand the basics of neural networks.
- To explain the functioning of deep neural networks.
- To analyze types of neural networks.
- To distinguish between different deep learning models.
- To study how practical problems are solved using suitable deep learning techniques.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: To understand the fundamentals of deep learning.

CO2: To apply the technique of Convolution Neural Network for implementing Deep Learning models.

CO3: To apply the technique of Recurrent Neural Network for implementing Deep Learning models.

CO4: To implement and apply deep generative models.

CO5: To apply deep learning techniques to practical problems.

Course Contents

UNIT-I: Fundamentals of Deep Learning **08 Hours**

Limitations of machine learning, introduction to deep learning. History of deep learning, advantages and challenges of deep learning. Introduction to neural networks: biological neuron, perceptron, multilayer feed-forward networks, feed-back networks, training neural networks: back propagation and forward propagation, activation functions: linear, sigmoid, tannh, hard tanh, softmax, rectified linear, loss functions, hyperparameters : learning rate, regularization, momentum, sparsity.

UNIT-II: Convolution Neural Network (CNN) 08 Hours

Introduction, CNN architecture overview, basic structure of convolutional network, padding, strides, typical settings, ReLU layer, pooling, fully connected layers, interleaving between layers, local response normalization, epoch of CNN. Introduction to transfer learning, popular CNN architectures and transfer learning techniques: LeNet, ResNet, VGGNet, AlexNet, DenseNet, PixelNet.

UNIT-III: Recurrent Neural Networks (RNN) 08 Hours

Unfolding computational graphs, recurrent neural networks, architectural overview, bidirectional RNNs – encoder-decoder sequence to sequence architectures – back-propagation through time for training RNN, vanishing and exploding gradients, the challenge of long-term dependencies, long short-term memory networks, gated recurrent unit.

UNIT-IV: Generative Adversarial Networks (GAN) 08 Hours

Introduction of GAN (Generative Modeling), Boltzmann machine, deep belief networks, different types of GANs, components of GANs, challenges faced by GANs, applications of GANs.

UNIT-V: Case Study and Applications 08 Hours

Image classification, social network analysis, speech recognition, recommender system, sentimental analysis, text preprocessing and ChatBot, video to text generation, image generation.

Learning Resources:

Text Books:

1. Josh Patterson, Adam Gibson Deep Learning: A Practitioner's Approach, O'Reilly Media, 2017.
2. Ian Goodfellow, YoshuaBengio and Aaron Courville, Deep Learning, MIT Press, 2017.
3. Nikhil Buduma, Fundamentals of Deep Learning Designing Next-Generation Machine Intelligence Algorithms O'Reilly.
4. R for Data Science by Hadley Wickham and Garrett Grolemund by O’Reilly Publication

Reference Books:

1. Umberto Michelucci Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks Apress, 2018.
2. Kevin P. Murphy Machine Learning: A Probabilistic Perspective, The MIT Press, 2012.
3. Giancarlo Zaccone, Md. Rezaul Karim, Ahmed Menshawy Deep Learning with TensorFlow: Explore neural networks with Python, Packt Publisher, 2017.
4. Kieran Healy, Data Visualization - A Practical Introduction ,Princeton University Press.
5. Antonio Gulli, Sujit Pal Deep Learning with Keras, Packt Publishers, 2017.
6. Francois Chollet, Deep Learning with Python, Manning Publications, 2017.

7. Goodfellow I., BengioY., and Courville A., Deep Learning, MIT Press, 2016, ISBN: 978-0262035613.
8. Alpaydin, E.,Introduction to Machine Learning, MIT Press, Prentice Hall of India, 3rd Edition 2014.

Ebooks:

1. Michael Nielsen, Neural Networks and Deep Learning, Online book, 2016. http://neuralnetworksanddeeplearning.com/

Web link for MOOC / NPTEL Links

1. Deep Learning, By Prof. Prabir Kumar Biswas, IIT Kharagpur, NPTEL, https://onlinecourses.nptel.ac.in/noc22_cs22/preview
2. NOC: Deep Learning- Part 1, By Prof. Mitesh M. Khapra, IIT Madras, NPTEL, https://archive.nptel.ac.in/courses/106/106/106106184/
3. Deep Learning for Visual Computing, By Prof. Debdoot Sheet, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc22_ee54
4. Introduction to Deep Learning, https://www.coursera.org/learn/introduction-to-deep-learning-boulder
5. Deep Learning Specialization: https://www.coursera.org/specializations/deep-learning

Activity based Learning (Suggested Activities in Class):

1. Flipped Classroom
2. Gamification
3. Online Interactive Tool
4. Collaborative and Individual Problem based learning
5. Quizzes/Assignment.

Course Code: 202203A - L	**Course Name: Deep Learning Lab**	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Practical : 2 Hours/Week	**1**	**OR :** 25 Marks

Tutorial and Term Work Guidelines:

Consider following guidelines while implementing deep learning models:

1. Consider any convenient dataset and pre-process the dataset.
2. Define the appropriate model structure.
3. Build the model and perform training.
4. Evaluate the model performance.
5. Predict for test data.
6. Analyze the obtained results.

List of Practicals

1. Write a program to build a logistic regression classifier with a Neural Network for prediction of house prices. Use Boston House price prediction dataset.
2. Perform binary classification using Deep Neural Networks to classify movie reviews into positive reviews and negative reviews, just based on the text content of the reviews. Use the IMDB dataset.
3. Build a Multiclass classifier using the CNN model. Use MNIST or any other suitable dataset.
4. Design an object detection model using CNN for simple objects. Use MNIST Fashion Dataset.
5. Apply pre-trained networks to a new task using transfer learning for a suitable application. Fine-tune the hyper-parameters and compare their performance.
6. Use the Google stock prices dataset and design a time series analysis and prediction system using RNN.
7. Design and implement Deep Convolutional GAN to generate images of faces/digits from a set of given Images.

Course Code: 202203B	Course Name: Cloud Computing and Security	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week	**3**	**CCE :** 50 Marks **ESE :** 50 Marks

Prerequisite Courses:

- Computer Network and Security, System Programming and Operating Systems, Cryptography and basic Information Security principles.

Course Objectives:

- Introduce foundational and advanced principles of cloud security to prepare students for securing modern cloud environments.
- Develop skills in managing identity and access in cloud platforms.
- Equip students to identify, assess and mitigate security risks in cloud services and applications while ensuring compliance with international standards.
- Enable the design and deployment of secure cloud applications using multi-tier architectures that utilize modern technologies like containers and serverless computing.
- Prepare students to implement advanced security models like Zero Trust in cloud environments.
- Provide knowledge on maintaining compliance and governance in dynamic cloud environments using automated auditing and regulatory tools.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Apply security measures and IAM policies to protect cloud environments, ensuring data integrity and access control.

CO2: Analyze compliance and security risks in cloud applications, and develop mitigation strategies for identified vulnerabilities.

CO3: Evaluate cloud security through simulated audits, DDoS protection, and secure API practices.

CO4: Apply knowledge on maintaining compliance and governance in dynamic cloud environments using automated auditing and regulatory tools.

CO5: Design advanced security models like Zero Trust and privacy-preserving techniques.

Course Contents

UNIT-I: Fundamentals of Cloud Computing Security 08 Hours

Introduction to Cloud Computing: Evolution, Characteristics, and Service Models (IaaS, PaaS, SaaS), Cloud Deployment Models: Public, Private, Hybrid, and Community Clouds, Overview of Cloud Security: Objectives and Threats, Virtualization and its Security Implications, Shared Responsibility Model in Cloud Security, Edge Computing and its Security Implications, Security Across the Data Lifecycle in the Cloud. ***Case Study:*** Key management strategies for cloud data security (KMS)

UNIT-II: Cloud Security Architecture and Design 08 Hours

Cloud Security Reference Architecture, Integration of Zero Trust principles, Identity and Access Management (IAM) in the Cloud, Secure Data Storage and Encryption Techniques, Cloud Network Security: Firewalls, VPNs, WAF and Intrusion Detection Systems, Security in Multi-Tenant Cloud Environments, Security Considerations in Cloud Application Development, Secure Software Development Life Cycle, Cloud-native Security Techniques. ***Case Study:*** Real-Time Monitoring using Cloud Native Tools: AWS CloudTrail, Azure Monitor

UNIT-III: Cloud Security Threats and Countermeasures 08 Hours

Common Cloud Security Threats: Data Breaches, Account Hijacking, Insider Threats, and Emerging Threats like Container Escape and Supply Chain Attacks, botnet attack, Attacks and Mitigation Strategies in the Cloud, Security in Cloud APIs: Risks and Best Practices, Incident Response and Recovery in Cloud Environments, Ransomware in Cloud Environments and Countermeasures, Real-Time Threat Intelligence for Proactive Security, and Case Studies of Cloud Security Breaches with Lessons Learned. ***Case Study:*** Threat Modeling Frameworks: STRIDE, PASTA

UNIT-IV: Cloud Security Standards and Compliance 08 Hours

Overview of Cloud Security Standards: ISO/IEC 27017, 27018, and CSA STAR, Regulatory Compliance in Cloud Computing: GDPR, HIPAA, and PCI-DSS, Legal Issues in Cloud Security: Data Sovereignty and Jurisdiction, Risk Management in Cloud: Identification, Assessment, and Mitigation, Security Audit and Certification in the Cloud, Emerging Regulations in Cloud Security, and Cloud Data Governance Strategies.

UNIT-V: Emerging Trends in Cloud Computing Security 08 Hours

Emerging Treats and Trends in Cloud Security: AI and ML in Cloud Threat Detection, Secure DevOps (DevSecOps) Practices in Cloud Environments, Privacy-Preserving Computation in the

Cloud, Blockchain for Cloud Security, Zero Trust Architecture in Cloud Security, Quantum-Safe Cryptography for Future Security Challenges, AI-driven Automated Threat Response, Chaos Engineering for Resilience Testing, and Future Directions in Cloud Security Research.

Learning Resources:

Text Books:

1. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance by Tim Mather, Subra Kumaraswamy, and Shahed Latif, O'Reilly Media, 2009. ISBN: 978-0596802769. https://books.google.co.in/books?id=BHazecOuDLYC&printsec=frontcover&redir_esc=y#v=onepage&q&f=false
2. Cloud Computing Security: Foundations and Challenges by John R. Vacca, CRC Press, 2016. ISBN: 978-1482260941
   https://repo.tzku.at/book/security/cloud/Cloud%20Computing%20Security%20-%20Foundations%20and%20Challenges%20(2016).pdf

Reference Books:

1. Security, Privacy, and Digital Forensics in the Cloud by Lei Chen, Hassan Takabi, and Nhien-An Le-Khac, Wiley, 2019. ISBN: 978-1119053287
   https://www.google.co.in/books/edition/Security_Privacy_and_Digital_Forensics_i/2NGGDwAAQBAJ?hl=en&gbpv=1&printsec=frontcover
2. Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS) by Michael J. Kavis, Wiley, 2014. ISBN: 978-1118617619
   https://books.google.co.in/books?id=NcrDAgAAQBAJ&newbks=0&printsec=frontcover&pg=RA1-PA2&hl=en&source=newbks_fb&redir_esc=y#v=onepage&q&f=false.
3. The Cloud Security Ecosystem: Technical, Legal, Business and Management Issues edited by Ryan Ko and Raymond Choo, Syngress, 2015. ISBN: 978-0128015957
   https://www.google.co.in/books/edition/The_Cloud_Security_Ecosystem/meycBAAAQBAJ?hl=en&gbpv=1&printsec=frontcover .

Web link for MOOC / NPTEL Links

1. https://www.udemy.com/course/introduction-cloud-computing/
2. https://learn.futureskillsprime.in/smartsearch?q=cloud+computing
3. https://onlinecourses.nptel.ac.in/noc21_cs14/preview.

Course Code: 202203B - L	Course Name: Cloud Computing and Security Lab	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Practical : 2 Hours/Week	**1**	**OR :** 25 Marks

List of Practicals (Any Five)

1. Apply security measures like firewalls, encryption, and access controls in your cloud environment to protect resources and data from unauthorized access.
2. Create and manage IAM policies and roles within AWS/Azure/GCP to enforce least-privilege access control, ensuring users and services have the correct permissions.
3. Enable and configure encryption for cloud storage services, ensuring secure data at rest and in transit. Implement automated backups and access controls.
4. Case Study- Perform a compliance assessment on a cloud-based application, checking it against standards like GDPR or HIPAA. Document and suggest necessary compliance actions.
5. Case Study- Conduct a risk assessment for a cloud service, identifying vulnerabilities. Create a mitigation plan with preventative and responsive measures to address identified risks.
6. Set up and test DDoS protection tools available in AWS/Azure/GCP. Simulate a DDoS attack to evaluate the effectiveness of these protections.
7. Design and implement a Zero Trust architecture for a cloud-based application, enforcing strict identity verification, least-privilege access, and continuous monitoring.

Course Code: 202203C		Course Name: Data Modeling and Visualization
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week	**3**	**CCE :** 50 Marks **ESE :** 50 Marks

Prerequisite Courses:

- Problem solving Approach.

Course Objectives:

- Creating a data model for the data to be stored in a database
- Conceptualized representation of Data objects
- Organize data description, data semantics, and consistency constraints of data
- Identifying data trends through data analysis
- Incorporate data visualization tools and use them in real time applications.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Design a probabilistic data modeling, interpretation, and analysis.

CO2: Analyze the characteristics and requirements of data and select an appropriate data model.

CO3: Describe methods to load, clean, transform, merge and reshape data.

CO4: Implement techniques for data analysis and visualization.

CO5: Integrate real world data analysis problems to visualize the Data using tools.

Course Contents

UNIT-I: Introduction to Data Modelling **08 Hours**

Basic probability: discrete and continuous random variables, independence, covariance, central limit theorem, Chebyshev inequality, diverse continuous and discrete distributions, statistics, parameter estimation, and fitting a distribution: descriptive statistics, graphical statistics, method of moments, maximum likelihood estimation. Data modeling - understand and model subtypes and supertypes, understand and model hierarchical data, understand and model recursive relationships, understand and model historical data.

UNIT-II: Data Modelling **08 Hours**

Random Numbers and Simulation: Sampling of continuous distributions, Monte Carlo methods Hypothesis Testing: Type I and II errors, rejection regions; Z-test, T-test, F-test, Chi-Square test,

Bayesian test.

Stochastic Processes and Data Modeling: Markov process, Hidden Markov Models, Poisson Process, Gaussian Processes, Auto-Regressive and Moving average processes, Bayesian Network, Regression, Queuing systems.

UNIT-III: Introduction to Data Visualization 08 Hours

Data Visualization Fundamentals: Principles, Types of Data Visualization, Presentation and Exploratory Graphics, Graphics and Computing, Statistical Historiography, Scientific Visualization Techniques: Scalar and Point techniques Vector Visualization techniques and multidimensional techniques Visualization design objectives. Key Factors – Purpose, visualization function and tone, visualization design options – Data representation, Data Presentation. Seven stages of data visualization. Higher-dimensional Displays and Special Structures, Static Graphics: Complete Plots, Customization, Extensibility, 3-D Plots, Output Formats, Data Handling.

UNIT-IV: Data Wrangling and Aggregation 08 Hours

Data Wrangling: Hierarchical Indexing, Combining and Merging Data Sets Reshaping and Pivoting. Data Visualization matplotlib: Basics of matplotlib, plotting with pandas and seaborn, other python visualization tools. Data Aggregation and Group operations: Group by Mechanics, Data aggregation, General split-apply-combine, Pivot tables and cross tabulation 67 Time Series Mapping - Time Series - Connections and Correlations - Scatterplot Maps - Trees, Hierarchies Recursion - Networks and Graphs, Data Abstraction. Task Abstraction, Analysis: Four Levels for Validation.

UNIT-V: Data Visualization Tools 08 Hours

Data Analysis: Date and Time Data Types and Tools, Time series Basics, date Ranges, Frequencies and Shifting, Time Zone Handling, Periods and Periods Arithmetic, Resampling and Frequency conversion, Moving Window Functions. Data Visualization Through Their Graph Representations: Data and Graphs Graph Layout Techniques, Force-directed Techniques Multidimensional Scaling, The Pulling under Constraints Model, Bipartite Graphs. Displaying Arbitrary Graphs-node link graph. Matrix representation for graphs- Info graphics

Data visualization tool- Tableau - Visualization using R.

Learning Resources:

Text Books:

1. Chun-houh Chen, Wolfgang Härdle, Antony Unwin, Handbook of Data Visualization, Springer.
2. Tamara Munzer, Visualization Analysis and Design -, CRC Press 2014 AlexandruTelea, Data Visualization Principles and Practice CRC Press 2014.

3. S. C. Gupta, V. K. Kapoor, Fundamentals of Mathematics Statistics (A Modern Approach) Sultan Chand & Sons Educational Publishers, Tenth revised edition, ISBN: 81-7014-791-3
4. R for Data Science by Hadley Wickham and Garrett Grolemund by O'Reilly Publication.

Reference Books:

1. Medhi, Statistical Methods: An Introductory Text, 2nd Edition, New Age International Ltd., ISBN:8122419577.
2. Ben Fry, Visualizing Data, O'Reilly Media.
3. Clous O.Wilke, Fundamentals of Data Visualization - A Primer on Making Informative and Compelling Figures, O'Reilly Media, Inc.
4. Kieran Healy, Data Visualization - A Practical Introduction ,Princeton University Press.
5. Robert Spence, Information Visualization An Introduction, Third Edition, Pearson Education, 2014.

Web link for MOOC / NPTEL Links

1. Computer Science and Engineering - NOC:Data Science for Engineers.
   https://onlinecourses.nptel.ac.in/noc21_cs69/preview
2. Computer Science and Engineering - NOC:Data Analytics with Python
   https://onlinecourses.nptel.ac.in/noc21_cs45/preview

Course Code: 202203C - L	**Course Name: Data Modeling and Visualization Lab**	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Practical : 2 Hours/Week	**1**	**OR :** 25 Marks

List of Practicals

1. Data loading, storage and file formats analyze sales data from multiple file formats
2. Data cleaning and preparation analyze customer churn in a telecommunications company
3. Data wrangling perform data wrangling on real estate market
4. Data visualization using matplotlib Analyze Air Quality Index (AQI) trends in a city
5. Data aggregation analyze sales performance by region in a retail company
6. Time series data analysis and visualization of stock market data.
7. Dashboard creation dashboard creation using visualization tools for the use cases: finance-marketing-insurance- healthcare etc.

Course Code: 202203D	Course Name: Agile Software Development	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week	**3**	**CCE :** 50 Marks **ESE :** 50 Marks

Prerequisite Courses:

- Software Engineering

Course Objectives:

- To understand the differences between conventional and agile approaches.
- To learn different tools used for agile project management.
- To study agile framework.
- To understand agile software design, development and testing.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Compare and contrast the differences between Agile and other project management methodologies.

CO2: Articulate agile design Principles and basics of Scaled Agile Framework.

CO3: Understand Agile Testing principles for real life situations.

CO4: Interpret and apply different principles, stages and activities of the Scrum methodology.

CO5: Use agile project management tools.

Course Contents

UNIT-I: Fundamentals of Agile **08 Hours**

Genesis of agile, introduction and background, agile manifesto and principles, overview of scrum, extreme programming, feature driven development, lean software development, agile project management, agile process model, design and development practices in agile projects, test driven development, continuous integration, refactoring, pair programming, simple design, user stories, agile testing methods.

UNIT-II: Agile Scrum Framework **08 Hours**

Introduction to scrum, project phases, agile estimation, planning game, product backlog, sprint backlog, iteration planning, user story definition, characteristics and content of user stories, acceptance tests and verifying stories, project velocity, burn down chart, sprint planning and

retrospective, daily scrum, scrum roles – product owner, scrum master, scrum team, scaled agile frameworks: safe, scrum@scale, disciplined agile, scrum case study.

UNIT-III: Agile Software Design and Development 08 Hours

Agile design practices, role of design principles including single responsibility principle, open closed principle, Liskov substitution principle, interface segregation principles, dependency inversion principle in agile design, need and significance of refactoring, refactoring techniques, continuous integration, automated build tools, scaled agile framework.

UNIT-IV: Agile Testing 08 Hours

Agile lifecycle and its impact on testing, Test-Driven Development (TDD), xUnit framework and tools for TDD, testing user stories - acceptance tests and scenarios, planning and managing testing cycle, exploratory testing, risk-based testing, regression tests, selenium agile testing, principles of agile testers, the agile testing quadrants, test automation and test management tools, test automation pyramid.

UNIT-V: Agile Product Management and Case Studies 08 Hours

Communication, planning, estimation, quality, risk, metrics and measurements, team collaborations, agile product management tools: JIRA, Trello, Asana: task tracking and management. Version control tools: Git, GitHub / GitLab: branching and collaboration in agile projects, automated testing tools: selenium, JUnit, postman for testing in agile, ci/cd tools: Jenkins, Bamboo: pipeline automation for agile projects, agile product management case studies.

Learning Resources:

Text Books:

1. Agile Project Management: Creating Innovative Products, Second Edition By Jim Highsmith, Addison-Wesley Professional, 2009
2. Robert C. Martin, Agile Software Development, Principles, Patterns and Practices, First International Edition, Prentice Hall.

Reference Books:

1. Kevin P. Murphy Machine Learning: A Probabilistic Perspective, The MIT Press, 2012.
2. Agile Project Management: Managing for Success, By James A. Crowder, Shelli Friess, Springer 2014
3. Ken Schawber, Mike Beedle, Agile Software Development with Scrum, International Edition, Pearson. Paperback 2002
4. Learning Agile: Understanding Scrum, XP, Lean, and Kanban, By Andrew Stellman, Jennifer Greene, 2015, O Reilly
5. Agile Testing: A Practical Guide For Testers And Agile Teams, Lisa Crispin, Janet Gregory, Pearson, 2010.

Web link for MOOC / NPTEL Links

1. Agile Software Development, https://www.edx.org/course/agile-software-development
2. Agile Software Development, https://www.coursera.org/learn/agile-software-development

Course Code: 202203D - L	**Course Name: Agile Software Development Lab**	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Practical : 2 Hours/Week	**1**	**OR :** 25 Marks

List of Practicals

1. Propose a sample project with clear objectives, use cases and UML diagrams
2. Compile release map and user stories for proposed project
3. Identify story boarding tasks, release plan and product road map in detail
4. Design story map for proposed project
5. Compile product backlog for proposed project
6. Compile Sprint backlog for proposed project
7. Demonstrate project with Sprint1, Sprint 2 releases with different tools used.

Course Code: 202204A	Course Name: Generative Artificial Intelligence	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week	**3**	**CCE :** 50 Marks **ESE :** 50 Marks

Prerequisite Courses:

- Calculus, Linear Algebra, Probability Theory, Data structures, Algorithms, Discrete Mathematics.

Course Objectives:

- Understanding the concepts and methods of artificial intelligence.
- Gaining insights into Generative AI and Responsible AI.
- Developing models for Generative AI.
- Applying AI approaches to design solutions for real-world problems.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Apply the principles of intelligent agents to various AI techniques.

CO2: Understand the foundational concepts of Generative AI.

CO3: Illustrate Generative AI models across diverse applications.

CO4: Identify features of responsible AI in AI applications.

CO5: To understand the impact of generative AI in various fields.

Course Contents

UNIT-I: Problem-Solving using AI Technique **08 Hours**

Introduction to AI and applications, structure of agents, informed (Heuristic) search strategies, unification and first-order inference, forward chaining, backward chaining, resolution, algorithms for classical planning, goal stack planning, heuristics for planning. Case study of route planning and navigation in GPS systems and mapping applications.

UNIT-II: Introduction to Generative AI **08 Hours**

Generative AI: introduction, difference between generative and discriminative models, history and evolution of generative AI, neural networks for generative AI, GenAI project life cycle, ML model building process, data collection and preprocessing, training and evaluation overview, deep learning techniques.

UNIT-III: Generative AI Models 08 Hours

Language models, transfer learning and pre-trained models, auto-encoders, variational auto-encoders, advanced generative AI models, GAN training techniques, GAN evaluation techniques, flow based models, introduction to generative AI creativity tools and examples.

UNIT-IV: Responsible AI 08 Hours

Responsible AI: Introduction, Principles and pillars of Responsible AI, Bias & Fairness: Explainability & Interpretability, Safety, Security, and Privacy. Metrics and Tools for RAI, Adversarial Testing, Explanations for Lime, SHAP, GradCam, Problems with generative models – Ethical Alignment Hallucination, Factual Correctness, Prompt Injection, Data Leakage, Deep Fakes, Copyright Infringement.

UNIT-V: Generative AI Applications 08 Hours

Generative AI in finance and business: algorithmic trading and financial forecasting, fraud detection and risk management, customer service and chatbots, marketing and advertising creativity, business process, automation and optimization. Generative AI in science and research: scientific discovery and hypothesis generation simulation and modeling in various fields, data augmentation and synthesis, collaboration and knowledge sharing, and ethical and social implications of generative AI.

Learning Resources:

Text Books:

1. Elaine Rich, Kevin Knight and Nair, Artificial Intelligence, TMH, 2017 ISBN978-0070087705.
2. David Foster, Generative Deep Learning, 2nd Edition April 2023, O'Reilly Media, Inc.ISBN: 9781098134181
3. Russell S. and Norvig P. Artificial Intelligence: A Modern Approach, Pearson Education, 4th edition, 2022, ISBN: 978-9356063570.
4. Avinash Manure, Shaleen Bengani, Saravanan S, Introduction to Responsible AI: Implement Ethical AI Using Python November 2023, ISBN-10 : 1484299817
5. Generative AI in Practice: 100+ Amazing Ways Generative Artificial Intelligence is Changing Business and Society, Bernard Marr
6. Responsible AI: Implementing Ethical and Unbiased Algorithms, by Shashin Mishra and Sray Agarwal.

Reference Books:

1. Nilsson Nils J, Artificial Intelligence: A new Synthesis, Morgan Kaufmann Publishers Inc. San Francisco, CA, ISBN: 978-1-55-860467-4.
2. Patrick Henry Winston, Artificial Intelligence, Addison-Wesley Publishing Company, ISBN: 0- 201-53377-4.

3. Dr. Lavika Goel, Artificial Intelligence: Concepts and Applications, Wiley publication, ISBN: 9788126519934
4. Dr. Nilakshi Jain, Artificial Intelligence, as per AICTE: Making a System Intelligent,Wiley publication, ISBN: 9788126579945
5. Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Education, ISBN: 9781259029981
6. David M. Patel , Artificial Intelligence & Generative AI for Beginners: Kindle Edition
7. Numa Dhamani and Maggie Engler, Introduction to Generative AI January 2024, ISBN 9781633437197
8. Virginia Dignum, Responsible Artificial Intelligence How to Develop and Use AI in a Responsible Way, Springer https://link.springer.com/book/10.1007/978-3-030-30371-6, ISBN 978-3-030-30371-6.
9. Generative Adversarial Networks Cookbook: Over 100 recipes to build generative models using Python, TensorFlow, and Keras by Josh Kalin.
10. Applications of Generative AI, Zhihan Lyu, Springer International Publishing, 2024.

Web link for MOOC / NPTEL Links

1. https://elearn.nptel.ac.in/shop/iit-workshops/completed/leveraging-generative-ai-for-teaching-programming-courses/?v=c86ee0d9d7ed
2. https://elearn.nptel.ac.in/shop/iit-workshops/completed/introduction-to-language-models/v=c86ee0d9d7ed
3. An Introduction to AI Prof. Mausam, IIT Delhi https://nptel.ac.in/courses/106/102/106102220/
4. Artificial Intelligence Prof Anupam Basu, Prof. S. Sarkar, IIT Kharagpur https://nptel.ac.in/courses/106/105/106105077/
5. Artificial Intelligence: Knowledge Representation and Reasoning, Prof Kemani IIT Madras https://nptel.ac.in/courses/106/106/106106140/
6. Responsible & Safe AI Systems Prof. Ponnurangam Kumaraguru, Prof. Balaraman Ravindran, IIIT Hyderabad, IIT Madras https://onlinecourses.nptel.ac.in/noc24_cs132/preview
7. Responsible AI in the Generative AI Era https://www.coursera.org/learn/responsible-ai-in-generative-ai
8. Generative AI with Large Language Models https://www.coursera.org/learn/generative-ai-with-llms.

Course Code: 202204B	Course Name: Ethical Hacking and Digital Forensics	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week	**3**	**CCE :** 50 Marks **ESE :** 50 Marks

Prerequisite Courses:

- Cryptography & Network Security.

Course Objectives:

- **Understand Ethical Hacking:** Introduce students to ethical hacking principles, tools, and techniques to protect systems from malicious attacks.
- **Learn Digital Forensics**: Equip students with the skills to investigate cybercrimes and gather digital evidence in a legally sound manner.
- **Identify Vulnerabilities:** Train students to identify and exploit vulnerabilities in various systems to assess their security posture.
- **Apply Legal and Ethical Standards:** Instill a strong understanding of legal and ethical standards governing cybersecurity and digital forensics.
- **Develop Countermeasures:** Enable students to develop and implement countermeasures to secure systems against potential threats.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Analyze security risks and apply ethical hacking techniques to identify potential vulnerabilities.

CO2: Perform forensic analysis on compromised systems and recover digital evidence.

CO3: Design and implement security solutions to protect systems from cyber threats.

CO4: Demonstrate an understanding of the legal implications of hacking and digital forensics in various jurisdictions.

CO5: Develop the competency to conduct ethical hacking in a controlled environment, adhering to professional ethical standards.

Course Contents

UNIT-I: Introduction to Ethical Hacking **08 Hours**

Basics of Ethical Hacking: Introduction, history, and evolution. **Types of Hackers:** Black hat,

white hat, and grey hat hackers. **Ethical Hacking Techniques:** Foot printing, scanning, enumeration, and vulnerability analysis. **Reconnaissance Tools:** Information gathering, social engineering. **Legal Implications:** Cyber laws and ethical considerations.

UNIT-II: Network and Web Application Security 08 Hours

Network security: Network protocols, firewalls, intrusion detection/prevention systems (IDS/IPS). **Web Application Security**: Common vulnerabilities (e.g., SQL injection, XSS). **Penetration Testing**: Tools and techniques for network and web security testing. **Wireless Network Security**: Wireless attacks, WPA/WPA2, securing wireless networks. **Case Studies**: Real-world scenarios of network and web application breaches.

UNIT-III: Advanced Ethical Hacking 08 Hours

Advanced exploitation: Buffer overflow, privilege escalation, evading IDS. **Malware Analysis**: Types of malware, reverse engineering, anti-virus evasion techniques. **Cloud Security**: Security challenges in cloud computing, cloud penetration testing. **Cryptography**: Encryption methods, cryptographic attacks, secure communication. **Security in Mobile Platforms**: Attacks on mobile platforms, securing mobile devices.

UNIT-IV: Introduction to Digital Forensics 08 Hours

Digital Forensics Process: Identification, collection, preservation, and analysis of digital evidence. **File System Forensics**: Windows, Linux, and Mac file systems analysis. **Network Forensics**: Traffic analysis, packet capturing, and network logs examination. **Incident Response**: Steps in handling and managing security incidents. **Legal Aspects of Forensics**: Understanding of chain of custody, evidence handling, and legal compliance.

UNIT-V: Advanced Digital Forensics and Case Studies 08 Hours

Forensic Tools: Overview of tools used in digital forensics (e.g., EnCase, FTK). **Mobile Device Forensics:** Techniques for analyzing data on smartphones and tablets. **Email and Web forensics:** Investigating email fraud, web attacks, and browser forensics. **Report Writing**: Documenting findings, forensic report writing, and expert witness testimony. **Case Studies and Emerging Trends**: Analysis of famous digital forensic cases, current trends, and future directions in digital forensics.

Learning Resources:

Text Books:

1. Ethical Hacking and Penetration Testing Guide by Rafay Baloch.
2. The Basics of Hacking and Penetration Testing by Patrick Engebretson.

3. Guide to Computer Forensics and Investigations by Bill Nelson, Amelia Phillips, and Christopher Steuart.
4. Nelson, B., Phillips, A., & Steuart, C. (2018). Guide to Computer Forensics and Investigations (6th ed.). Cengage Learning.
5. McClure, S., Scambray, J., & Kurtz, G. (2012). Hacking Exposed 7: Network Security Secrets and Solutions. Tata McGraw Hill.
6. Stallings, W. (2020). Cryptography and Network Security: Principles and Practice (8th ed.). Pearson Education.

Reference Books:

1. Hacking: The Art of Exploitation by Jon Erickson
2. Network Forensics: Tracking Hackers through Cyberspace by Sherri Davidoff and Jonathan Ham
3. Digital Forensics and Incident Response by Gerard Johansen
4. Practical Malware Analysis by Michael Sikorski and Andrew Honig
5. Applied Cryptography by Bruce Schneier.

Web link for MOOC / NPTEL Links

1. Ethical Hacking By Prof. Indranil Sen Gupta, IIT Kharagpur
2. https://onlinecourses.nptel.ac.in/noc22_cs13/preview.
3. https://hackaday.com/
4. https://breakthesecurity.cysecurity.org/
5. https://www.eccouncil.org/programs/certified-ethical-hacker-ceh/
6. https://www.hackthissite.org/

Course Code: 202204C	Course Name: Information Retrieval and Web Mining	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week	**3**	**CCE :** 50 Marks **ESE :** 50 Marks

Prerequisite Courses:

- Data Structures and Algorithms, Probability and Statistics, Artificial Intelligence.

Course Objectives:

- Explore the theoretical foundations of Information Retrieval (IR), including indexing, scoring, and term weighting.
- Investigate advanced IR techniques like query expansion, relevance feedback, and probabilistic models.
- Develop skills to evaluate search engine performance using effectiveness and efficiency metrics.
- Gain practical knowledge in designing and operating web crawlers for IR systems.
- Examine emerging IR trends, including AI models, ethical issues, and industry case studies

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Comprehend key concepts of Information Retrieval, including Boolean retrieval, indexing, and evaluation metrics.

CO2: Apply advanced techniques like relevance feedback, query expansion, and probabilistic IR models.

CO3: Design and implement security solutions to protect systems from cyber threats.

CO4: Design and implement web crawlers, applying clustering and similarity measures.

CO5: Identify and address ethical issues in IR systems, and assess their real-world impact.

Course Contents

UNIT-I: Theoretical Foundations of Information Retrieval **08 Hours**

Boolean retrieval, term vocabulary and postings lists, dictionaries and tolerant retrieval, index construction, index compression, scoring, term weighting and the vector space model, computing scores in a complete search system, evaluation in information retrieval.

UNIT-II: Advanced Techniques in Information Retrieval 08 Hours

Relevance feedback and query expansion, XML retrieval, probabilistic information retrieval, text classification and Naive Bayes, vector space classification, flat clustering, matrix decompositions and latent semantic indexing.

UNIT-III: Search Engine Evaluation 08 Hours

Evaluating Search Engines: Effectiveness metrics, efficiency metrics, training, testing, and statistics, classification and clustering - classification and categorization, clustering, social search - user tags and manual indexing, searching with communities, filtering and recommending, peer-to-peer and Metasearch.

UNIT-IV: Web Crawling 08 Hours

Basic Crawler Algorithm: Breadth-first crawlers, preferential crawlers, implementation issues, fetching, parsing, stop word removal and stemming, link extraction and canonicalization, spider traps, page repository, concurrency universal crawlers, scalability, coverage vs freshness vs importance, focused crawlers, topical crawlers: topical locality and cues, best-first variations, adaptation, evaluation, crawler ethics and conflicts.

UNIT-V: Emerging Trends and Case Studies 08 Hours

Explainable AI in IR and web mining, ethical challenges: bias, fairness, and privacy in IR systems, case studies on industry applications: Google, Amazon, Netflix, research trends: Federated learning, zero-shot IR, and few-shot learning, large-scale datasets for IR and web mining (e.g., TREC, ClueWeb, Common Crawl), applications of generative AI in IR: GPT-based models for conversational search.

Learning Resources:

Text Books:

1. Introduction to Information Retrieval by Christopher D. Manning, Prabhakar Raghavan, and Hinrich Schütze.
2. Mining the Web: Discovering Knowledge from Hypertext Data by Soumen Chakrabarti.

Reference Books:

1. Modern Information Retrieval: The Concepts and Technology Behind Search by Ricardo Baeza-Yates and Berthier Ribeiro-Neto.
2. Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data by Bing Liu Search Engines: Information Retrieval in Practice by Bruce Croft, Donald Metzler, and Trevor Strohman.

Course Code: 202204D	Course Name: DevOps	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week	**3**	**CCE :** 50 Marks **ESE :** 50 Marks

Prerequisite Courses:

- Cloud Computing, Operating Systems, Programming Skills, Networking.

Course Objectives:

- Understand and apply DevOps principles and practices to modern software development.
- Gain proficiency in Git for version control, including collaboration and code management.
- Set up and manage CI/CD pipelines using tools like Jenkins to automate development processes.
- Use Ansible, Docker, and Kubernetes for configuration management, containerization, and orchestration of applications.
- Implement Infrastructure as Code (IaC) and set up monitoring and security systems for cloud-based environments.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand DevOps principles and the DevOps lifecycle for efficient software delivery.

CO2: Use Git for version control, manage code, and resolve merge conflicts.

CO3: Set up and automate CI/CD pipelines using Jenkins for integration and deployment.

CO4: Implement containerization using Docker and orchestrate applications with Kubernetes.

CO5: Apply Infrastructure as Code (IaC) with Terraform and Cloud Formation for cloud Infrastructure management.

Course Contents

UNIT-I: Introduction to DevOps and Version Control with Git 08 Hours

DevOps Overview: Principles (CALMS, CAMS), DevOps lifecycle, Benefits, DevOps vs. traditional methods, Delivery pipeline. Git Fundamentals: Basic commands (clone, commit, push, pull), Advanced commands (rebase, cherry-pick), Git workflows (feature branching, Git Flow), Collaboration with GitHub, Merge conflict management.

UNIT-II: Continuous Integration (CI) and Deployment/Delivery (CD) 08 Hours

CI/CD Concepts: Importance of CI/CD, Automating build, test, and deployment pipelines. Jenkins for CI/CD: Setting up Jenkins pipelines, Integrating Git, Automated testing, Continuous Deployment strategies, Jenkins monitoring and reporting.

UNIT-III: Configuration Management, Containerization and Orchestration 08 Hours

Configuration Management: Tools (Ansible, Puppet, Chef), Writing Ansible playbooks, Managing configuration with Puppet, Chef automation practices. Containerization with Docker: Docker basics, Creating Docker images, Managing containers, Docker Compose, Networking in Docker. Kubernetes: Architecture (Pods, Replica Sets, Deployments), Kubernetes clusters, Service discovery, Networking, Rolling updates, Helm for package management

UNIT-IV: Infrastructure as Code (IaC), Monitoring, Logging, and Security 08 Hours

IaC Concepts: Terraform, AWS CloudFormation, Best practices in IaC, Managing infrastructure with code. Monitoring & Logging: Prometheus for monitoring, Grafana for visualization, ELK Stack for centralized logging, Alerting strategies.

UNIT-V: Cloud Providers, Services and Security 08 Hours

Cloud Providers: AWS, Azure, Google Cloud, Cloud service models (IaaS, PaaS, SaaS), Cloud security best practices. Security in DevOps: DevSecOps, Automated security testing, Vulnerability scanning, Cloud security (IAM, encryption).

Learning Resources:

Text Books:

1. 1.Joakim Verona, Practical Devops, 2016.

Reference Books:

1. DevOps Tools from Practitioner’s Viewpoint, Kindle Edition by Deepak Gaikwad.

Course Code: 202205	Course Name: MOOC -I	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Practical : 4 Hours/Week	**2**	**TW** : 50 Marks

Prerequisite Courses:

- MOOCs, or Massive Open Online Courses, are online learning platforms that provide access to educational content to a large number of learners worldwide supported by NPTEL. They aim to democratize education by making high-quality learning resources available to anyone with an internet connection. This course provides lifelong learning and skill development among students, focusing on a complete understanding of recent trends in computer engineering and research.
- Students need to go through a minimum of 8 weeks of NPTEL course online and pursue the certification by appearing in an exam organized by NPTEL at the designated center. If a student fails to get the NPTEL certification of specified course, they must complete an alternative assignment list provided under courses, which covers practical aspects ensuring that students can demonstrate their understanding through hands-on projects and case studies.

Course Code: 202205A	Course Name: MOOC # Research Publication and Ethics	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Practical : 4 Hours/Week	**2**	**TW** : 50 Marks

Prerequisite Courses:

- Research Methodology

Course Objectives:

The purpose of this course is to engage student researchers in reading about, understanding and discussing the responsible code of conduct of interdisciplinary scientific research. Specific learning objectives with respect to research ethics include:

- To know rules, issues, options, and resources for research ethics
- To familiarize with various institutional ethics review boards/academic integrity guidelines
- To understand the purpose and value of ethical decision-making
- To have a positive disposition towards continued learning about research ethics.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand the philosophy of science and ethics, research integrity and publication ethics.

CO2: Identify and comprehend traditional and current issues in Ethics.

CO3: Apply the use of indexing and citation databases, open access publications, research metrics and plagiarism tools.

CO4: Develop aware of moral & ethics in research conduction, drafting, presentation, publication.

CO5: Maintain originality and integrity at all levels of research and impact of research with different measuring indices.

Course Contents

UNIT-I: Philosophy, Ethics and Scientific Conduct **05 Hours**

Introduction to Philosophy: Scope, concept, branches. Ethics: definition-moral philosophy, nature of moral judgments. **Ethics with respect to Science and Research:** Intellectual honesty and research integrity. **Scientific Misconducts:** Falsification- Fabrication, and Plagiarism - Redundant publications, Selective reporting and misrepresentation of data.

UNIT-II: Publication Ethics 05 Hours

Publication Ethics: definition, introduction and importance, best practices/ standards setting initiatives and guidelines: COPE, WAME etc. **Publication Misconduct:** definition, concept, problems etc. Violation of publication ethics, authorship and contributor ship; Identification of publication misconduct, complaints and appeals, Predatory publishers and journals.

UNIT-III: Open Access Publishing 05 Hours

Open access publications and initiatives, OER- Open licenses- types & uses. SHERPA/ ROMEO online resource to check publisher copyright and self- archiving policies etc.

UNIT-IV: Publication Misconduct 06 Hours

Subject-specific issues, FFP, authorship, Conflicts of interest, Complaints and appeals: examples and fraud from India and abroad, Software tools: Introduction- Turnitin, Urkund and other open source software tools.

UNIT-V: Databases and Research Metrics 06 Hours

Databases-Indexing databases, Citation databases: Web of Science, Scopus, etc. Research Metrics-Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score, Metrics: h-index, g-index, etc.

Learning Resources:

Text Books:

1. Joakim Verona, Practical Devops, 2016.
2. Nicholas H. Steneck. Introduction to the Responsible Conduct of Research. Office of Research Integrity. 2007. Available at: https://ori.hhs.gov/sites/default/files/rcrintro.pdf
3. Responsible Conduct of Research By Adil E. Shamoo; David B. Resnik Oxford University Press, 2003
4. Ethics in Science Education, Research and Governance Edited by Kambadur Muralidhar, Amit Ghosh Ashok Kumar Singhvi. Indian National Science Academy, 2019. ISBN: 978-81-939482-1-7.

Reference Books:

1. The Student's Guide to Research Ethics By Paul Oliver Open University Press, 2003.
2. Anderson B.H., Dursaton, and Poole M.: Thesis and assignment writing, Wiley Eastern 1997.
3. Bijorn Gustavii: How to write and illustrate scientific papers? Cambridge University Press.
4. Bordens K.S. and Abbott, B.b.: Research Design and Methods, Mc Graw Hill, 2008.
5. Graziano, A., M., and Raulin, M.,L.: Research Methods – A Process of Inquiry, Sixth Edition, Pearson, 2007.

Web link for MOOC / NPTEL Links

1. Research and Publication Ethics: https://onlinecourses.swayam2.ac.in/nou22_ge73/preview
2. Introduction to Research: https://onlinecourses.nptel.ac.in/noc20_ge22/preview
3. Research Ethics: https://onlinecourses.swayam2.ac.in/ugc19_ge04/preview

Course Code: 202205B	Course Name: MOOC # AI for Economics	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Practical : 4 Hours/Week	**2**	**TW** : 50 Marks

Prerequisite Courses:

- Problem Solving Approach.

Course Objectives:

- To understand fundamentals of Software Engineering.
- To practice various testing technics.
- To understand the various version control tools.
- To understand project management through lifecycle.
- To understand various advance practices.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand Software Development process and its models.

CO2: Analyze the cost estimation of project and use of version control tools.

CO3: Apply a suitable project management strategy to manage a project.

CO4: Applying various methods by using advance tools.

CO5: Understand the Implementation of emerging technologies along with ethics.

Assignments:

1. **Analyze a real-world economic dataset using AI techniques.**
   - Choose a dataset (e.g., GDP growth, unemployment rates, or trade balances).
   - Use machine learning tools (e.g., Python, R) to clean, preprocess, and analyze the data.
   - Visualize trends and draw economic insights.

2. **Predicting Economic Indicators.**

   Objective: Develop a predictive model for an economic variable.

   - Use time-series forecasting techniques (e.g., ARIMA, LSTMs) to predict indicators like inflation or stock market performance.
   - Evaluate model performance using metrics like RMSE or MAPE.
   - Provide a report on the implications of your predictions.

3. Define **cooperative game theory** and **non-cooperative game theory**. Discuss the key differences, focusing on:

- The presence of binding agreements.
- The role of coalitions in cooperative games.
- Individual rationality in non-cooperative games.

a) Cooperative Games – Shapley Value and Core

Scenario: Three players (A, B, C) form a coalition to complete a project:

- Contribution values: A=40, B=30, C=20.
- Total benefit of cooperation: 120.
- Subset payoffs: {A, B} = 90, {A, C} = 70, {B, C} = 60.

Tasks:

- Compute the **Shapley Value** to distribute payoffs.
- Determine if the allocation is in the **Core**.

b) Non-Cooperative Games – Nash Equilibrium

- Explain the concept of **Nash Equilibrium** with an example.
- Derive the Nash Equilibrium for the following game matrix:

	Player B: Strategy 1	**Player B: Strategy 2**
Player A: Strategy 1	(3, 3)	(0, 5)
Player A: Strategy 2	(5, 0)	(1, 1)

4. Real-**Time Auction Simulation -** Develop a Python/MATLAB/R program to simulate various auction formats:

1. English Auction
2. Dutch Auction
3. Sealed-Bid Auctions (First-Price and Second-Price)

- Include options to set the number of bidders, valuation distributions, and reserve prices.
- Visualize the results, showing revenue, bidder payoffs, and efficiency.

5. Case Studies**: Customer Behavior Analysis for Recommender Systems**

- Example 1: Netflix - Movie and TV Show Recommendations
- Example 2: Amazon - E-commerce Recommendations

Real Time Assignment

1. Real-World Case Study

Objective: Apply AI to solve a specific economic problem.

Assignment:

- Select a real-world economic issue (e.g., poverty, inflation, trade imbalances).
- Use AI tools to analyze the problem and propose solutions.
- Present findings in a written report or presentation.

OR

1. **Bayesian Games in Security**

Scenario: A company must secure two servers (S1S_1S1 and S2S_2S2) from potential cyberattacks.
The attacker chooses one server to attack, with success probabilities p1p_1p1 and p2p_2p2 depending on the company's defense allocation.

- The defender does not know which server the attacker will target but has a belief about the attacker's preference (θ\thetaθ) for S1S_1S1 or S2S_2S2**.**

Tasks:

- Model the game as a Bayesian game.
- Assume the attacker's type (θ\thetaθ) follows a distribution P(θ)P(\theta)P(θ).
- Find the Bayesian Nash Equilibrium strategies for both players.

Deliverables:

- Mathematical model of the game.
- Code implementation to solve for equilibrium.
- Report analyzing the effectiveness of defense strategies.

Web link for MOOC / NPTEL Links

1. https://onlinecourses.nptel.ac.in/noc24_cs76/preview

Course Code: 202205C	Course Name: MOOC # Industry 4.0 and Industrial IoT	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Practical : 4 Hours/Week	**2**	**TW** : 50 Marks

Prerequisite Courses:

- Basic Programming Knowledge, IoT, Networking, Basic Data Analytics & Big Data Concepts, Cyber Security Basics, Cloud Computing Basics, Industrial Automation & Manufacturing Processes, Operating Systems Basics.

Course Objectives:

- Equip students with the foundational knowledge and practical skills required to design, implement, and secure IoT systems for industrial applications.
- Enable students to understand the key concepts of Industry 4.0, including smart factories, cyber-physical systems, and the role of big data and AI in transforming industries.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand the Foundations of Industry 4.0 and IIoT.

CO2: Explore Advanced Technologies and Cyber Security.

CO3: Apply IIoT Solutions in Industry-Specific Domains.

CO4: Integrate Big Data and Cloud Computing for Industrial Applications.

Assignments

This course is based on NPTEL MOOCs, and provides a comprehensive introduction to Industrial IoT and Industry 4.0 concepts, focusing on topics such as smart factories, cyber-physical systems, big data, AI, and industrial automation. If a student fails to pass the NPTEL MOOC, they are required to complete an alternative assignment list that covers practical aspects of IIoT, cybersecurity, cloud computing, and real-world industrial applications, ensuring that students can demonstrate their understanding through hands-on projects and case studies

Learning Resources:

Text Books:

1. Introduction to Industrial Internet of Things and Industry 4.0, CRC Press, Taylor and Francis Group By Sudip Misra, Chandana Roy, Anandarup Mukherjee.
2. Introduction to IoT. Cambridge University Press by S. Misra, A. Mukherjee, and A. Roy,

2020.

3. Rapid manufacturing: an industrial revolution for the digital age by Hopkinson, N., Hague, R. and Dickens, P. eds., 2006, John Wiley & Sons.

Web link for MOOC / NPTEL Links

1. Introduction to Industry 4.0 and Industrial Internet of Things By Prof. Sudip Misra | IIT Kharagpur https://onlinecourses.nptel.ac.in/noc24_cs95/preview
2. Social Innovation in Industry 4.0 By Prof. Janakranjan Ramkumar, Prof. Amandeep Singh Oberoi | IIT Kanpur https://onlinecourses.nptel.ac.in/noc24_me126/preview

An alternative set of assignments that can be considered for course evaluation in case the student fails to pass the MOOC.

Assignments:

Faculty can design assignments based on following topics.

1. Overview of Industry 4.0 Concepts.
2. Design a Smart Factory System.
3. Cyber Security Measures for Industrial IoT.
4. Case Study: Application of Industrial IoT in Healthcare.
5. Industrial IoT Sensing & Actuation.
6. Big Data Analytics in Industrial IoT.
7. Industrial IoT Communication Networks.
8. Security in IIoT: Vulnerability Assessment.
9. Industrial IoT for Smart Agriculture.
10. Student Project - Real-Time IIoT Monitoring System.

Course Code: 202205D	Course Name: MOOC # Ethical Hacking	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Practical : 4 Hours/Week	**2**	**TW** : 50 Marks

Prerequisite Courses:

- Problem Solving Approach.

Course Objectives:

- Understand and apply ethical hacking techniques within a controlled environment.
- Identify vulnerabilities and suggest mitigation strategies.
- Develop an understanding of ethical and legal frameworks in cyber security

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand Software Development process and its models.

CO2: Analyze the cost estimation of project and use of version control tools.

CO3: Apply a suitable project management strategy to manage a project.

Assignments:

1. Install Kali Linux or any ethical hacking toolkit in a virtual machine (e.g., VirtualBox or VMware). Set up a vulnerable machine (e.g., Metasploitable, OWASP Juice Shop, or DVWA) to practice safely.
2. Use tools like Nmap or Zenmap to scan the vulnerable machine for open ports and services.Document the results of your scan, including any services and vulnerabilities discovered.
3. Using the vulnerabilities found in Task 2, attempt to exploit them using Metasploit or similar tools. Gain access to the target machine and gather basic information (e.g., OS version, users).
4. Based on the vulnerabilities you exploited, propose and implement mitigation measures to secure the system. Re-scan the system to confirm the vulnerabilities are resolved.
5. Use tools like John the Ripper or Hydra to perform a dictionary attack on a weak password. Highlight the importance of strong password policies.

Real Time Assignments:

1. Scenario 1: You are hired as a cybersecurity analyst to test the security of a fictitious company's IT infrastructure. Your task is to identify potential vulnerabilities, suggest countermeasures, and create a report summarizing your findings.

   OR

2. Scenario 2: You are hired as an ethical hacker to test the security of a company’s simulated

network or web application. Your task is to conduct penetration testing to identify weaknesses and prepare a report on your findings and solutions.

Learning Resources:

Web link for MOOC / NPTEL Links

1. Coursera: https://www.coursera.org/learn/ethical-hacking-essentials-ehe#modules
2. https://www.edx.org/learn/information-security/ec-council-ethical-hacking-essentials-ehe

Course Code: 202206	Course Name: Research Seminar-I	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Practical : 4 Hours/Week	**2**	**TW** : 50 Marks

Prerequisite Courses:

- Problem solving Approach.

Course Objectives:

- To explore the basics principal of communication (verbal & non-verbal).
- To identify the real world problems and to find the optimize solution with new technology implementation.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Analyze the real world problems to provide optimize solutions.

CO2: Understand different methods for solutions.

CO3: Study a recent topics and understand implementation.

Course Content:

This is the platform for students to present and discuss their research work, findings, and ideas in front of peers and faculty members. Each student will get allotted to a guide. It is recommended to allot the guide with mutual domain and area of interest from the commencement of semester. Once assigned, students should schedule a one-on-one meeting with their guides to discuss the research direction, project scope, resources, and milestones. Topic selection for an M.Tech journey is one of the most crucial steps in a student's research. It shapes the direction of the entire research work and determines the relevance and feasibility of the study. To ensure that the topic selection process is structured, fair, and productive, it is recommended that The topic selection for the research seminar must include recent trends and detailed literature survey. Students must confirm that they have access to the required tools, software, datasets, and hardware.

Evaluation will be done not only by considering presentations skills but also the attentiveness, regularity and the efforts taken throughout the semester. Panel of staff members along with a guide would be assessing the seminar work based on these parameters-Topic, Contents and Presentation, regularity, Punctuality and Timely Completion, Question and Answers, Report, Paper presentation/Publication, Attendance and Active Participation.

Students will have to submit a seminar report along with seminar workbook. This workbook will be a

continuous evaluation which will include guide remarks after each visit for each student. It is recommended to use following points for report.

- Title Page with Title of the topic, Name of the candidate with Exam Seat Number / Roll Number,
- Name of the Guide, Name of the Department, Institution and Year and University
- Seminar Approval Sheet/Certificate
- Abstract and Keywords
- Acknowledgements
- Table of Contents, List of Figures, List of Tables and Nomenclature
- Chapters Covering topic of discussion- Introduction with section including organization of the report, Literature Survey/Details of design/technology/Analytical and/or experimental work, if any/Discussions.
- Conclusions
- Bibliography/References
- Plagiarism Check report
- Report Documentation page

Guides must follow the below mentioned Rubrics for seminar guides to evaluate students' performance.

Sr. No	Activity	Level	Achievement	Grade	Achievement	Grade
1	Conference	National	Participation	B	Prize Winner	A
2		International	Participation	B+	Prize Winner	A+
3		International (Scopus)	Participation	A+	Prize Winner	O
4	Journal Publications	With ISSN No.		B		
5		Listed by UGC		A		
6		Listed by SCOPUS		A+		
7		Listed by SCI / SCIE		O		

Learning Resources:

Reference Books:

1. Rebecca Stott, Cordelia Bryan, Tory Young, Speaking Your Mind: Oral Presentation and Seminar Skills (Speak-Write Series), Longman, ISBN-13: 978-0582382435.

Course Code: 202207	Course Name: Skill Development Laboratory-II	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Practical : 2 Hours/Week	**1**	**TW** : 25 Marks

Prerequisite Courses:

- Java Programming, Data Structures and Algorithms, DBMS, Networking.

Course Objectives:

- Understand and apply advanced features of the Java programming language.
- Develop and deploy web applications using Servlets, JSP, and JavaBeans on popular servers like Apache Tomcat.
- Understand the life cycle and structure of Java Servlets and web application directories.
- Develop effective server-side components within Java web applications.
- Understand and implement client-server interaction through TCP/IP programming in Java.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Develop client-server communication applications.

CO2: Implement dynamic, server-side web content using Servlets and JSP.

CO3: Utilize the JSF application framework to build user interfaces.

CO4: Develop JSP pages by integrating JavaBeans for reusable components.

CO5: Apply the Model-View-Controller (MVC) design pattern to build robust client-server Skill Development lab -I (Advance Java).

Course Content:

1. Develop Java-Based Calculators Using GUI and Exception Handling
2. Advanced Java TCP Socket Programming for Wired Networks with Bidirectional Communication, Secure File Transfer, and Robust Error Handling
3. SetUp Apache Tomcat and Develop a Servlet for Managing User Authentication and Authorization
4. Develop an MVC-Based Fitness Tracking System.
5. Build a Simple CRUD Application Using JavaServer Faces (JSF) and a Database.
6. Develop a Mini Project Using All Learned Concepts (Any one).

   Sample Mini Project Topics:

a. Develop an Online Quiz Application Using JSP and MySQL.
b. Develop an Online Course Management System Using Servlets, JSP, and MySQL.
c. Develop a Customer Feedback System Using JavaBeans.

Learning Resources:

Text Books:

2. Robert W. Sebesta, Programming the World Wide Web, 4th Edition, Pearson education, 2008.

https://dokumen.pub/qdownload/programming-the-world-wide-web-seventh-edition-1292024313-9781292024318-9781292037219-1292037210.html

Reference Books:

1. Schildt, H. (2018). Java: The complete reference (11th ed.). McGraw-Hill Education. Basham, B., Sierra, K., & Bates, B. Head first Servlets and JSP (2nd ed.). O'Reilly Media.

https://github.com/phanhuy/java-documents/blob/master/(O'Reilly)---Java%20Servlet%20and%20JSP%20Cookbook---(2004).chm

Web link for MOOC / NPTEL Links

1. https://www.udemy.com/course/advanced-java-programming/